EXHIBIT E
Part 1 of 3

File History Report

☒ Paper number **File Wrapper Jacket / :Table of Contents** is missing from the United States Patent and Trademark Office's original copy of the file history. No additional information is available.

☐ The following page(s) _____ of paper number _____ is/are missing from the United States Patent and Trademark Office's original copy of the file history. No additional information is available

Additional comments: **7137775 10-806775**

Search Notes	Application/Control No.	Applicant(s)/Patent under Reexamination	
	10/806,775	HOPKINS, LAWRENCE G.	
	Examiner	Art Unit	
	Ninh H. Nguyen	3745	

SEARCHED			
Class	Subclass	Date	Examiner
Above	Updated	10/6/2006	NHN

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
Updated East search	10/6/2006	NHN
Interference search history printout		

U.S. Patent and Trademark Office

Part of Paper No. 20061006

Search Notes

Application/Control No.	Applicant(s)/Patent under Reexamination	
10/606,775	HOPKINS, LAWRENCE G.	
Examiner	**Art Unit**	
Ninh H. Nguyen	3745	

SEARCHED			
Class	Subclass	Date	Examiner
above	updated	8/7/2006	NHN

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
Updated East search	8/7/2006	NHN

U.S. Patent and Trademark Office — Part of Paper No. 20060807

Search Notes	Application/Control No.	Applicant(s)/Patent under Reexamination	
	10/806,775	HOPKINS, LAWRENCE G.	
	Examiner	Art Unit	
	Ninh H. Nguyen	3745	

SEARCHED			
Class	Subclass	Date	Examiner
Updated	above	1/23/2006	NHN

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
Updated East search	1/23/2006	NHN
Interference search history printout		

U.S. Patent and Trademark Office

Part of Paper No. 01232006

Search Notes	Application/Control No.	Applicant(s)/Patent under Reexamination	
	10/806,775	HOPKINS, LAWRENCE G.	
	Examiner	Art Unit	
	Ninh H. Nguyen	3745	

SEARCHED			
Class	Subclass	Date	Examiner
Updated	above	12/1/2005	NHN

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
Updated East search	12/1/2005	NHN
Interference search history printout		

U.S. Patent and Trademark Office

Part of Paper No. 12012005

Search Notes	Application/Control No.	Applicant(s)/Patent under Reexamination	
	10/806,775	HOPKINS, LAWRENCE G.	
	Examiner	Art Unit	
	Ninh H. Nguyen	3745	

SEARCHED			
Class	Subclass	Date	Examiner
Updated		8/4/2005	NHN

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
Updated East search	8/4/2005	NHN

Search Notes	Application No.	Applicant(s)	
	10/806,775	HOPKINS, LAWRENCE G.	
	Examiner	Art Unit	
	Ninh H. Nguyen	3745	

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Class	Subclass	Date	Examiner
Updated		4/20/2005	NHN
415	60, 61		
	108, 177		
	119		
416	120		
417	3, 423.5		
	426		
454	338		

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner
All	above	4/20/2005	NHN

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
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Consulted with Joyce (454) Freay (417)		

U.S. Patent and Trademark Office

Part of Paper No. 04202005

Search Notes	Application No.	Applicant(s)	
	10/806,775	HOPKINS, LAWRENCE G.	
	Examiner	Art Unit	
	Ninh H. Nguyen	3745	

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Class	Subclass	Date	Examiner
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INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
East search	9/10/2004	

U.S. Patent and Trademark Office

Part of Paper No. 09102004

Index of Claims

Application No.	Applicant(s)
10/806,775	HOPKINS, LAWRENCE G.
Examiner	**Art Unit**
Ninh H. Nguyen	3745

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	+	Restricted	I	Interference	O	Objected

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Claim		Date
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U.S. Patent and Trademark Office

Part of Paper No. 09102004

Index of Claims

Application/Control No.	Applicant(s)/Patent under Reexamination
10/806,775	HOPKINS, LAWRENCE G.
Examiner	**Art Unit**
Ninh H. Nguyen	3745

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	+	Restricted	I	Interference	O	Objected

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Claim Final	Claim Original	Date
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Issue Classification	Application/Control No. 10/806,775	Applicant(s)/Patent under Reexamination HOPKINS, LAWRENCE G.
	Examiner Ninh H. Nguyen	Art Unit 3745

ISSUE CLASSIFICATION

ORIGINAL CLASS	ORIGINAL SUBCLASS	INTERNATIONAL CLASSIFICATION CLAIMED	NON-CLAIMED
415	61	F 04 D 25 /16	/

CROSS REFERENCES												
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)											
415	119				/				/			
416	120				/				/			
417	3	423.5	426		/				/			
					/				/			
					/				/			

(Assistant Examiner) (Date)	NINH H. NGUYEN PRIMARY EXAMINER 10/06/06 (Primary Examiner) (Date)	Total Claims Allowed: 30	
KCooper 10/11/06 (Legal Instruments Examiner) (Date)		O.G. Print Claim(s) 1	O.G. Print Fig. 17

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

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U.S. Patent and Trademark Office

Part of Paper No. 20061006

Issue Classification	Application/Control No.	Applicant(s)/Patent under Reexamination
	10/806,775	HOPKINS, LAWRENCE G.
	Examiner	Art Unit
	Ninh H. Nguyen	3745

ISSUE CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)							
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)						
415	61	415	119						
INTERNATIONAL CLASSIFICATION		416	120						
F 0 4 D	25/16	417	3	423.5	426				
	/								
	/								
	/								
	/								

(Assistant Examiner) (Date)

(Legal Instruments Examiner) (Date)

NINH H. NGUYEN
PRIMARY EXAMINER
01/23/06
(Primary Examiner) (Date)

Total Claims Allowed: 31

O.G. Print Claim(s)	O.G. Print Fig.
1	17

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

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U.S. Patent and Trademark Office

Part of Paper No. 01232006

Issue Classification	Application No.	Applicant(s)	
	10/806,775	HOPKINS, LAWRENCE G.	
	Examiner	Art Unit	
	Ninh H. Nguyen	3745	

ISSUE CLASSIFICATION

ORIGINAL					CROSS REFERENCE(S)						
CLASS				SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					
415				61	415	119					
INTERNATIONAL CLASSIFICATION					416	120					
F	0	4	D	25/16	417	3	423.5	426			
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				/							
				/							
				/							

(Assistant Examiner) (Date)

(Legal Instruments Examiner) (Date) 4/23/05

Ninh H. Nguyen 04/20/05
NINH H. NGUYEN
PRIMARY EXAMINER
(Primary Examiner) (Date)

Total Claims Allowed: 31

O.G. Print Claim(s)	O.G. Print Fig.
1	17

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

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Issue Classification	Application/Control No.	Applicant(s)/Patent under Reexamination	
	10/806,775	HOPKINS, LAWRENCE G.	
	Examiner	Art Unit	
	Ninh H. Nguyen	3745	

ISSUE CLASSIFICATION

ORIGINAL CLASS	ORIGINAL SUBCLASS	CROSS REFERENCE(S) CLASS	CROSS REFERENCE(S) SUBCLASS (ONE SUBCLASS PER BLOCK)						
415	61	415	119						
INTERNATIONAL CLASSIFICATION		416	120						
F 0 4 D	25/16	417	3	423.5	426				
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////////////////// (Assistant Examiner) (Date)	Ninh H. Nguyen 12/01/05 NINH H. NGUYEN PRIMARY EXAMINER (Primary Examiner) (Date)	Total Claims Allowed: 31
K Cooper 12-1-05 (Legal Instruments Examiner) (Date)		O.G. Print Claim(s): 1 / O.G. Print Fig.: 17

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

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U.S. Patent and Trademark Office — Part of Paper No. 12012005

US007137775B2

(12) **United States Patent**
Hopkins

(10) **Patent No.: US 7,137,775 B2**
(45) **Date of Patent: Nov. 21, 2006**

(54) **FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS**

(75) Inventor: **Lawrence G. Hopkins**, Portland, OR (US)

(73) Assignee: **Huntair Inc.**, Tualatin, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/806,775**

(22) Filed: **Mar. 22, 2004**

(65) **Prior Publication Data**

US 2004/0185771 A1 Sep. 23, 2004

Related U.S. Application Data

(63) Continuation-in-part of application No. PCT/US04/08578, filed on Mar. 19, 2004.

(60) Provisional application No. 60/554,702, filed on Mar. 20, 2004, provisional application No. 60/456,413, filed on Mar. 20, 2003.

(51) **Int. Cl.**
F04D 25/16 (2006.01)

(52) **U.S. Cl.** **415/61**; 415/119; 416/120; 417/3; 417/423.5; 417/426

(58) **Field of Classification Search** 415/60, 415/61, 108, 177, 119; 416/120; 417/3, 417/423.5, 426; 454/338
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,156,233	A	11/1964	O'Connell	126/110
3,332,621	A	7/1967	Tanner	
3,898,019	A	8/1975	Reznick et al.	
4,021,213	A	5/1977	Neidhardt et al	62/180
4,133,374	A	1/1979	York	
4,158,527	A	6/1979	Burkett	
4,241,871	A	12/1980	Newell, III et al.	
4,426,960	A	1/1984	Hart	
4,494,006	A	1/1985	Staroselsky et al	
4,651,922	A *	3/1987	Noba	236/35
4,767,262	A *	8/1988	Simon	415/119
4,800,653	A	1/1989	Steffen	
5,136,465	A	8/1992	Beuck et al.	
5,210,680	A	5/1993	Scheibler	
5,269,660	A	12/1993	Pradelle	
5,370,576	A *	12/1994	Krofchalk	454/143
5,546,272	A	8/1996	Moss et al.	
5,572,403	A	11/1996	Mills	
5,632,677	A	5/1997	Elkins	
5,664,995	A	9/1997	O'Keefe	
5,701,750	A	12/1997	Ray	62/160

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0205979 A1 12/1986

OTHER PUBLICATIONS

AAON, RL Series Rooftop Conditioners, Sep. 2001.

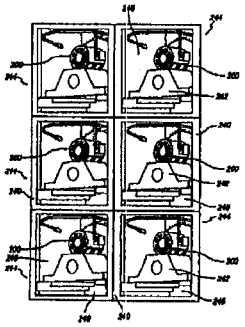
(Continued)

Primary Examiner Ninh H. Nguyen
(74) *Attorney, Agent, or Firm* Silicon Valley Patent Group LLP

(57) **ABSTRACT**

A fan array fan section in an air-handling system includes a plurality of fan units arranged in a fan array and positioned within an air-handling compartment. One preferred embodiment may include an array controller programmed to operate the plurality of fan units at peak efficiency. The plurality of fan units may be arranged in a true array configuration, a spaced pattern array configuration, a checker board array configuration, rows slightly offset array configuration, columns slightly offset array configuration, or a staggered array configuration.

30 Claims, 15 Drawing Sheets



U.S. PATENT DOCUMENTS

5,745,041	A		4/1998	Moss
5,787,971	A		8/1998	Dodson
5,788,568	A		8/1998	Ito et al. 454/188
5,793,610	A		8/1998	Schmitt et al.
6,031,717	A		2/2000	Baddour et al.
6,072,397	A	*	6/2000	Ostrowski 340/588
6,155,335	A		12/2000	Acre et al.
6,257,832	B1		7/2001	Lyakowski et al.
6,386,826	B1		5/2002	Jacob
6,386,969	B1		5/2002	O'Brien
6,388,880	B1		5/2002	El-Ghobashy et al.
6,407,918	B1		6/2002	Edmunds et al.
6,414,845	B1		7/2002	Bonet
6,427,455	B1		8/2002	Furubayashi
6,436,130	B1		8/2002	Philips et al.
6,463,891	B1		10/2002	Algrain et al
6,648,590	B1		11/2003	Huang et al.
6,675,739	B1		1/2004	Terrell et al.
6,791,836	B1		9/2004	Cipolla et al. 361/687
6,792,766	B1		9/2004	Osborne et al 62/159
6,961,248	B1		11/2005	Vincent et al. 361/796
2005/0180846	A1		8/2005	Hopkins 415/119
2005/0232753	A1		10/2005	Hopkins 415/119

OTHER PUBLICATIONS

Jim Parro (Marketing Mananager for AAON) New Promotional Literature The RL Series.

AAON, RL Series 45 to 230 tons Packaged Rooftop Conditioners & Air Handlers

AAON, Invoice No. 265184, Feb 28, 2002.

AAON, Order Form and Associated Documents, Nov. 14, 2001.

Osborne, W.C. and Turner, C.G., co-editors, "Woods Practical Guide to Fan Engineering," 1964, cover pages and pp 121, 137-138, 146-148, 208, and 218, Benham and Company, Colchester, England

Wilcke, William F. and Morey, R. Vance, "Selecting Fans, Determining Airflow for Crop Drying, Cooling, Storage," 1998, 8 pages, Regents of the University of Minnesota.

The Parallel and Series Operation, Sunon Group web page, http://www.sunon.com/english/wealthtech/tech-06.htm, at least as early as Mar. 15, 2004, 2 pages, Sunon Group, Taiwan.

Series and Parallel Fans, HighBeam Research web page, www://static.highbeam.com/m/machinedesign/january261995/seriesandparallelfans/index.htm, Jan. 26, 1995, 1 page, HighBeam Research, LLC.

Mcleod, Ian, Using Fans in Series and Parallel Performance Guidelines, ebmpapst web page, htt:/www.papstplc.com/features/articles/art006&print=true, at least as early as Mar 15, 2004, 3 pages, emb-Papst Automotive and Drives (UK) Ltd., UK

Technical Bulletin. CLEANPAK M/R/PF Multi/Redundant/Plenum Fan, at least as early as Mar. 15, 2004, 3 pages, CLEANPAK International, Clackmas, Oregon.

Installation Operating and Maintenance Manual, 2003, 12 pages, Greenheck Fan Corp., Schofield, Wisconsin.

DPI. Series—Delhi Plenum Fan: Installation and Maintenance Instructions, Nov. 2001, 2 pages, Delhi Industries Inc., Delhi, Ontario, Canada

AAON worksheet and drawing regarding Borders East Towers job for customer Borders Group, dated Feb. 26, 2001 and Feb. 6, 2001 (2 pages).

AAON order form, estimating worksheet, and facsimile transmission regarding The Commons job, dated Sep. 15, 1998, Sep. 30, 1998 and Jun. 30, 1998 (3 pages).

AAON wiring diagram assignment and verification regarding Farm Show Arena job, Apr. 1, 2002 (1 page).

AAON worksheet and drawing regarding Harrison Hills job, both dated Feb. 26, 2002 (2 pages).

AAON RL Feature Master Number sheet, dated Oct. 17, 2001 (1 page).

Mammouth Selection Guide for Custom Penthouse (200-410 Tons Cooling-only VAV configurations, 1992 (14 pages).

* cited by examiner

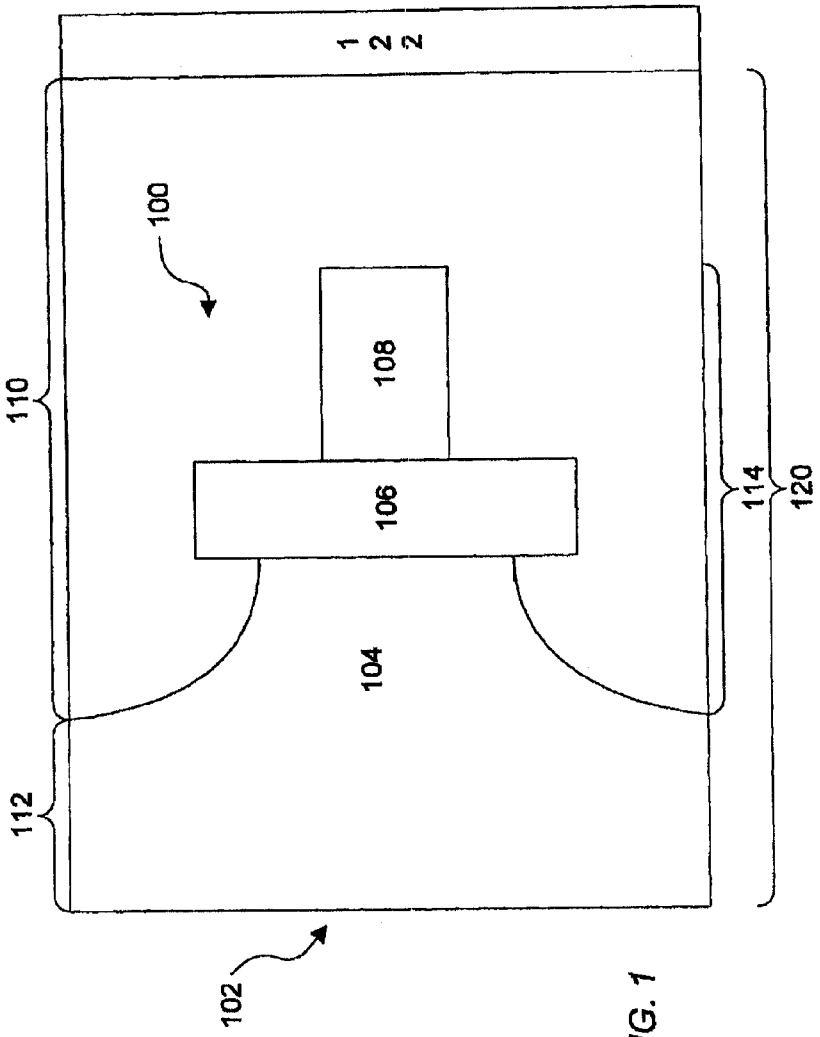


FIG. 1

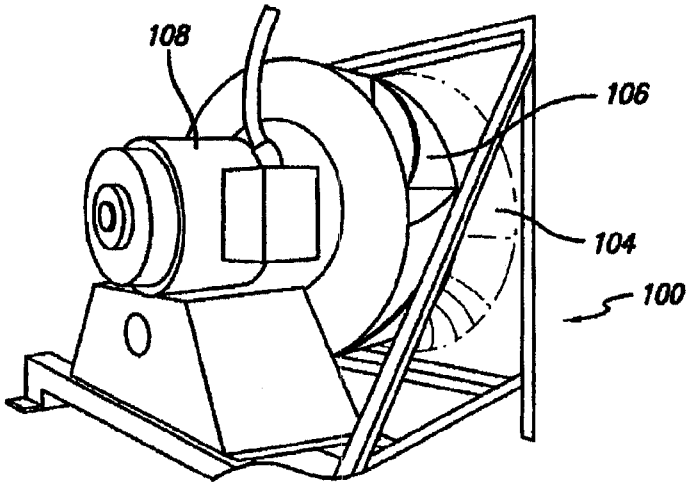


FIG. 2

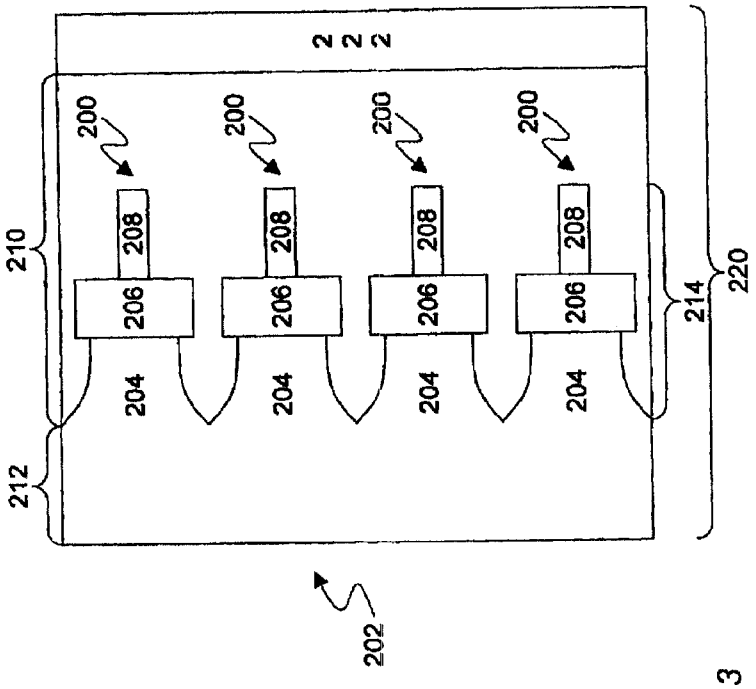

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FIG. 3

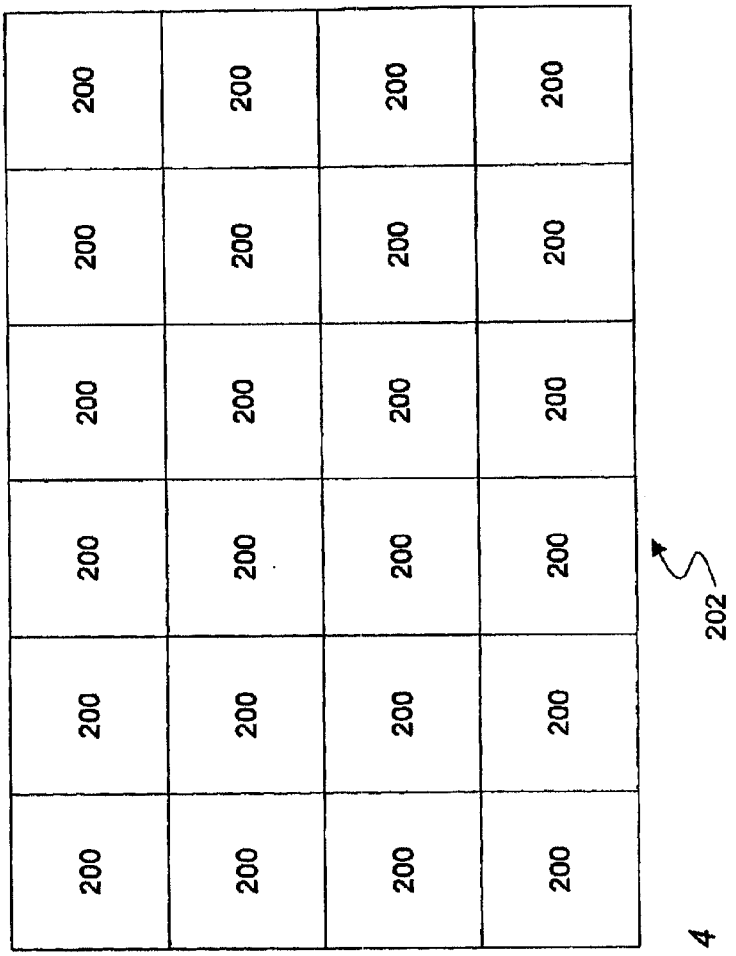

FIG. 4

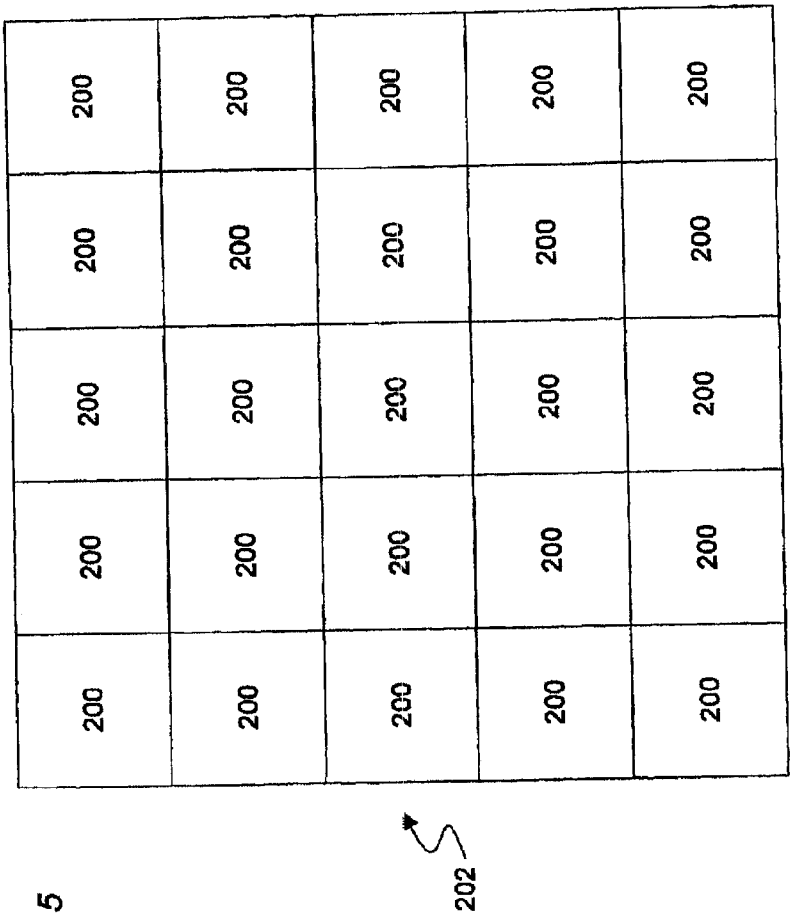

FIG. 5

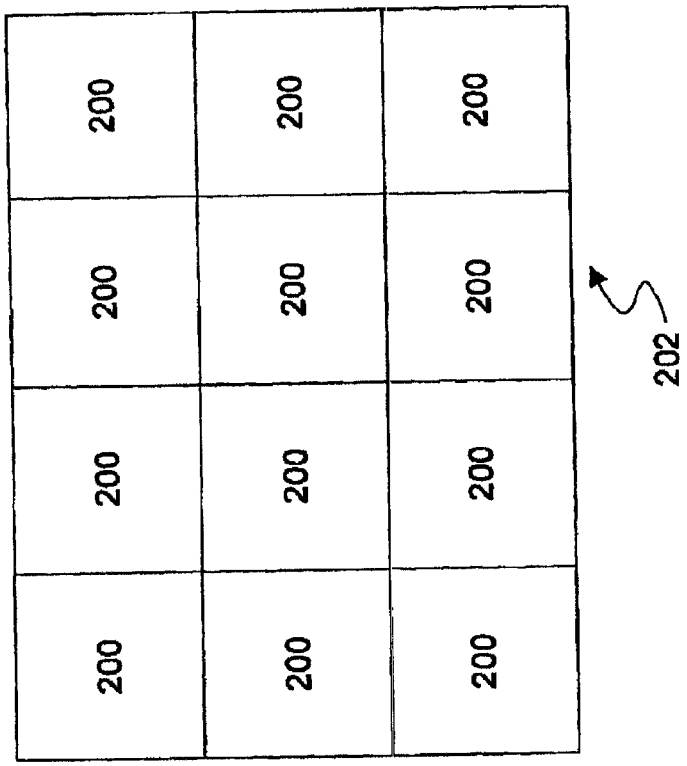

FIG. 6

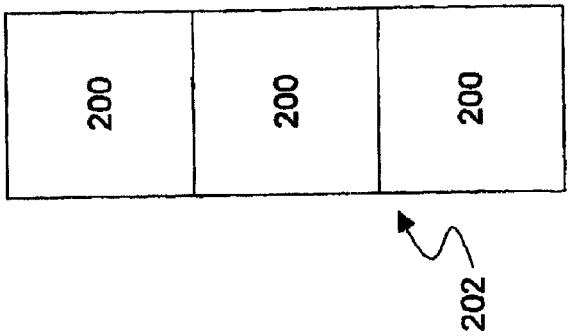

FIG. 8

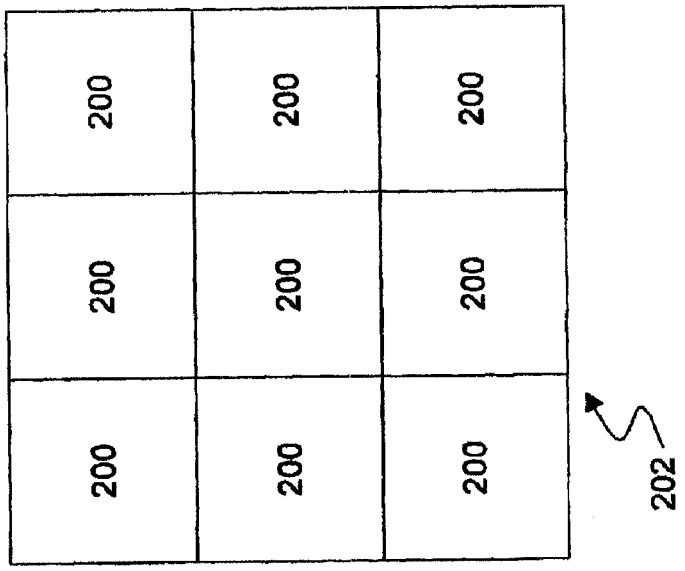

FIG. 7

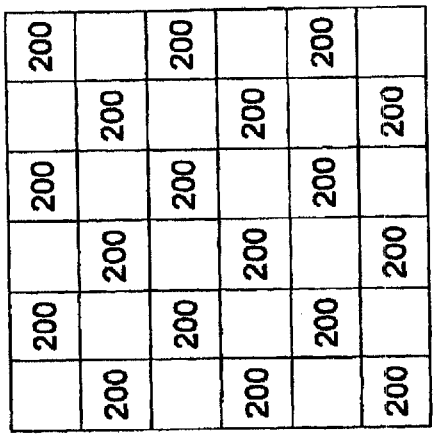

FIG. 10

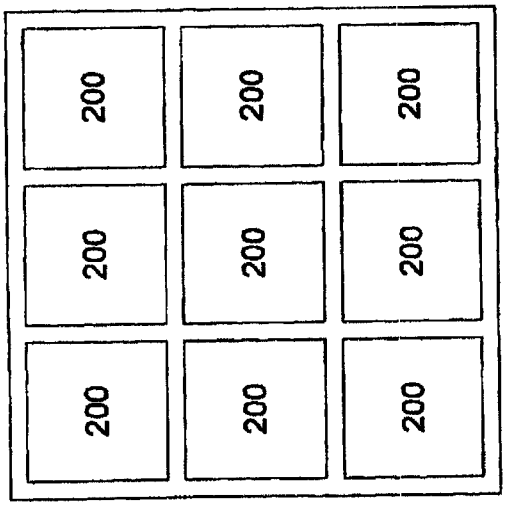

FIG. 9

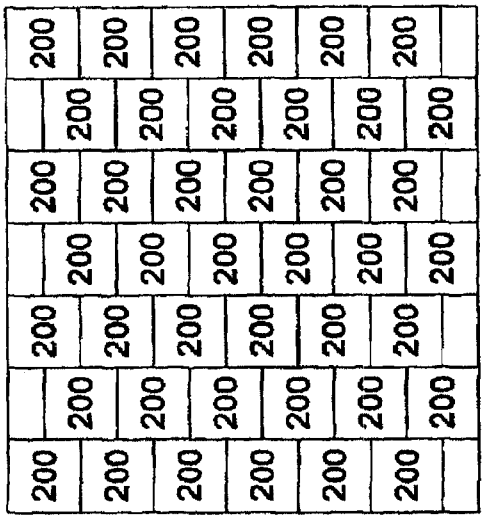

FIG. 12

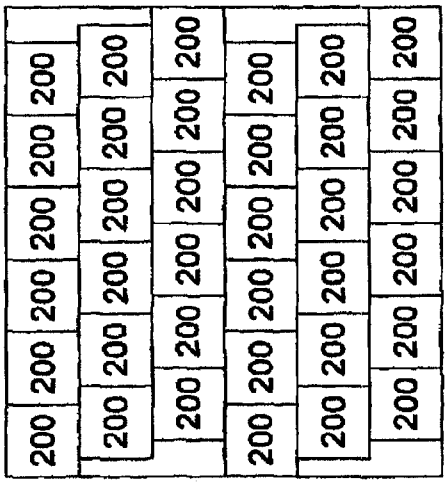

FIG. 11

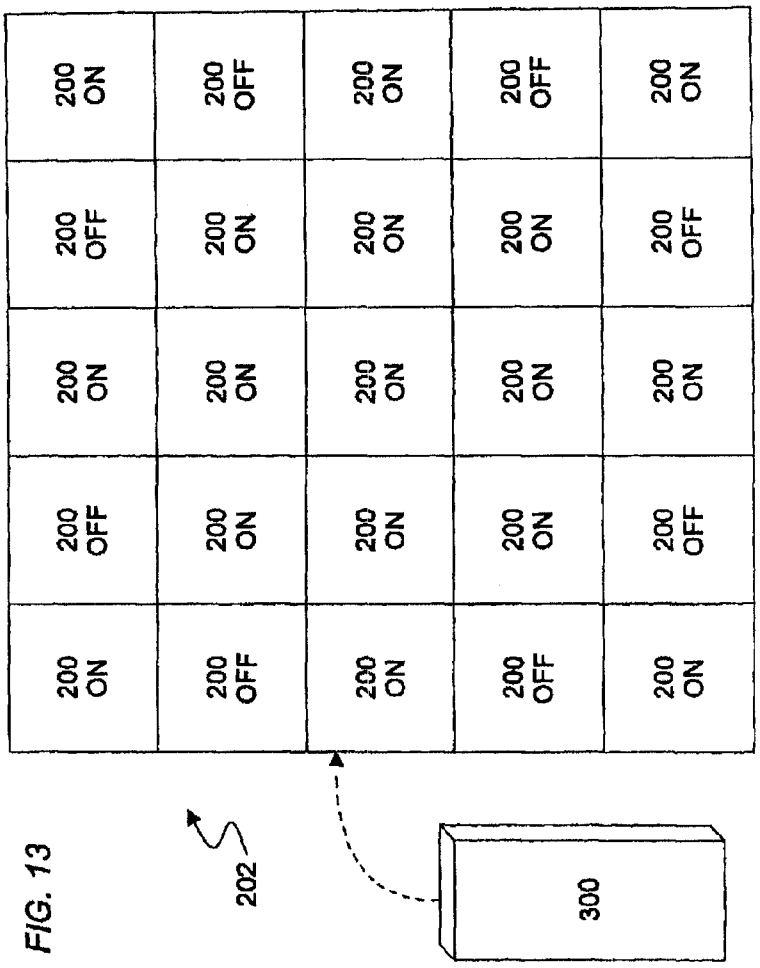
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FIG. 13

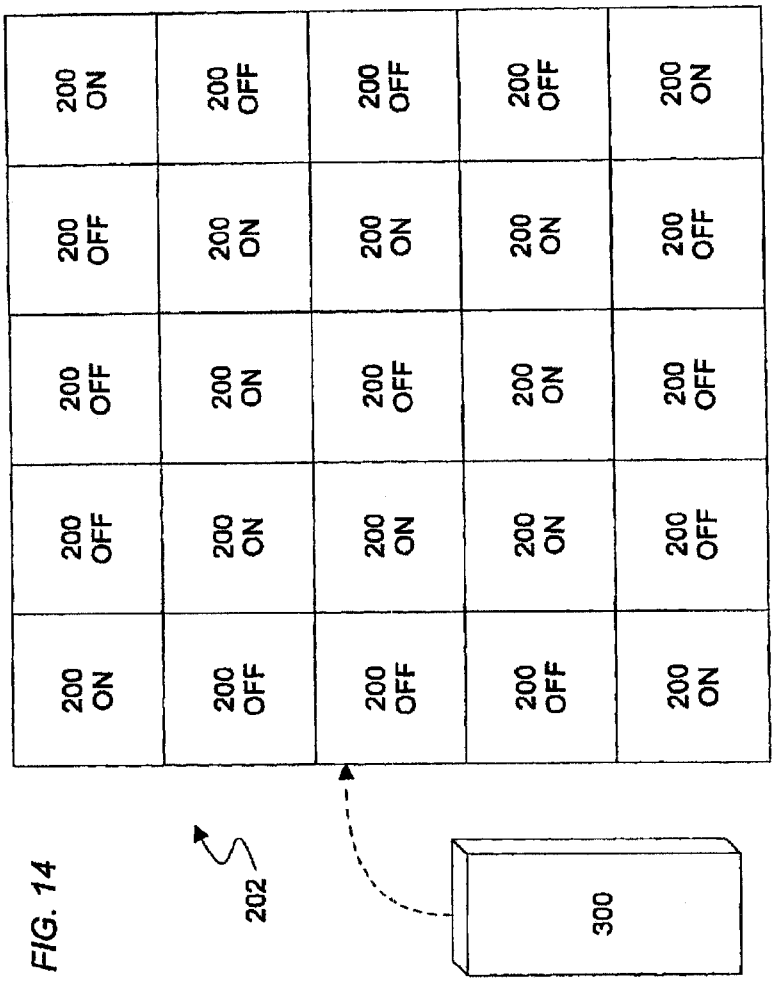
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FIG. 14

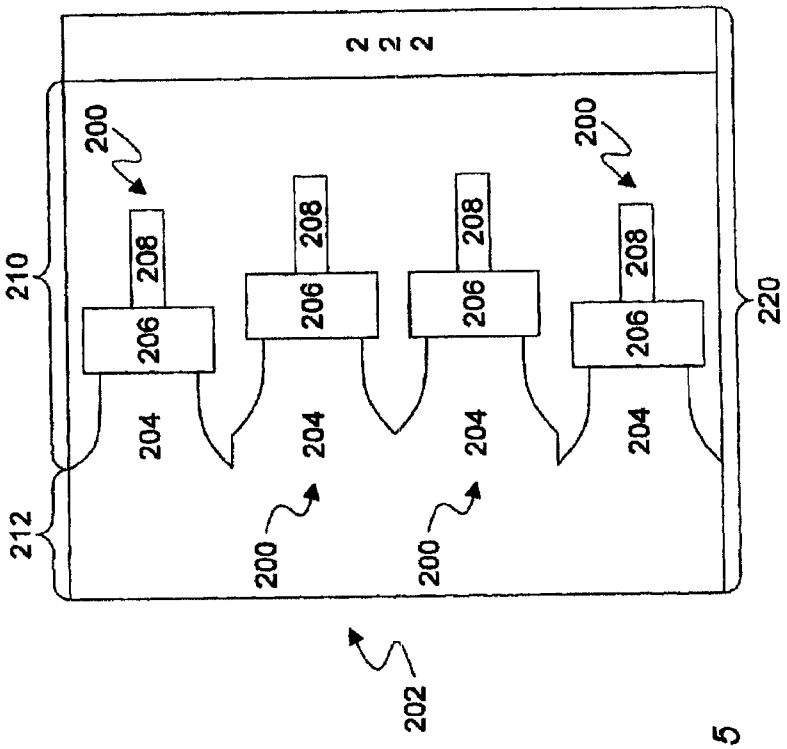

FIG. 15

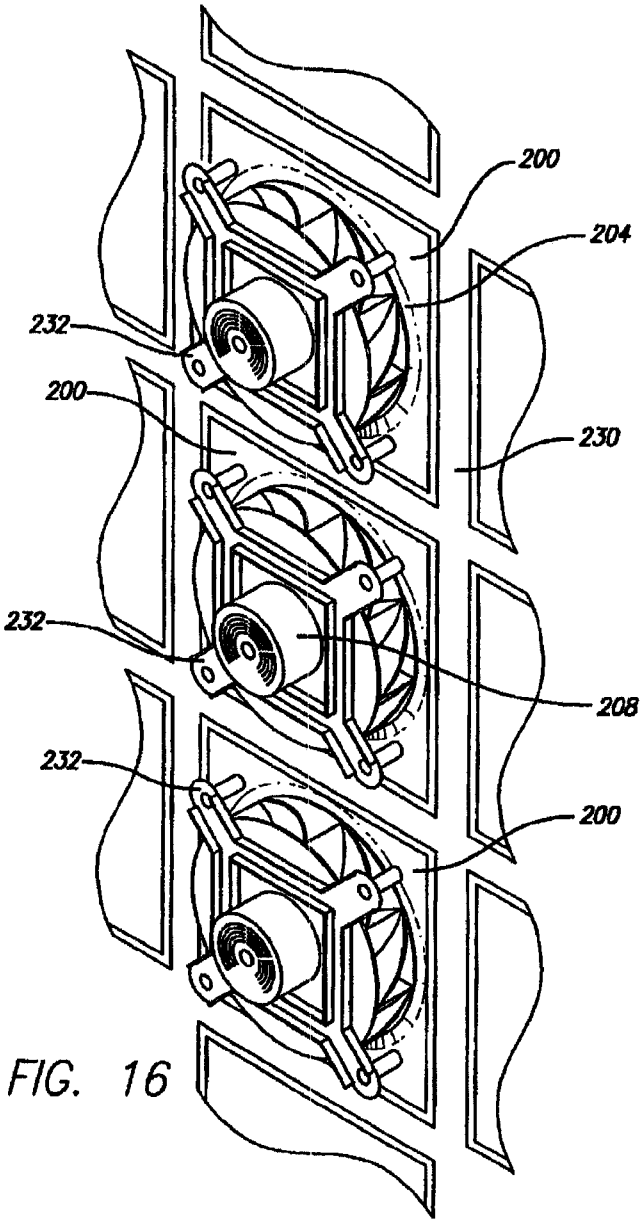

FIG. 16

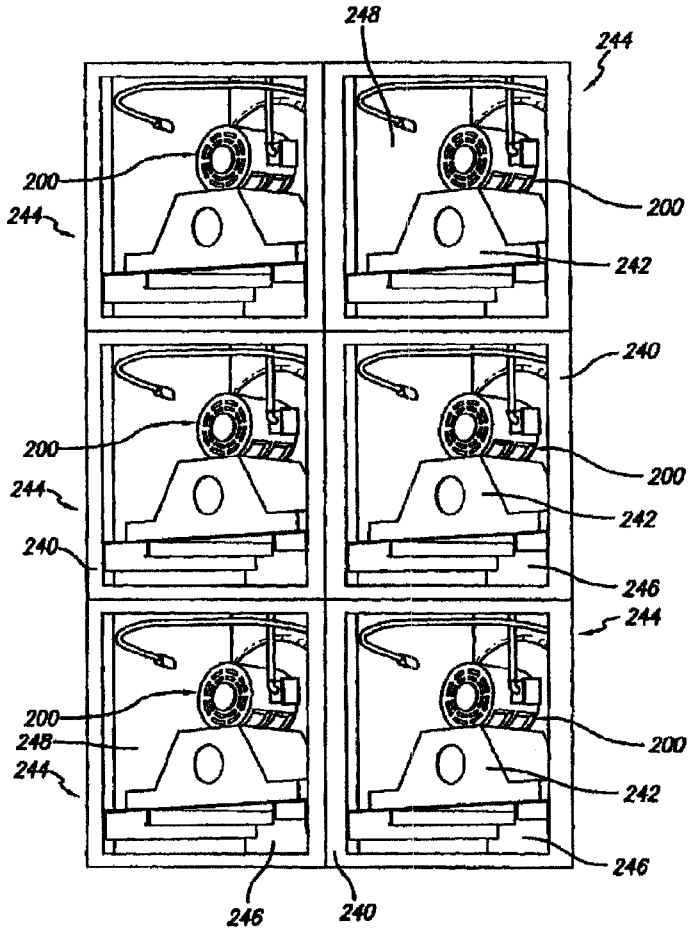
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FIG. 17

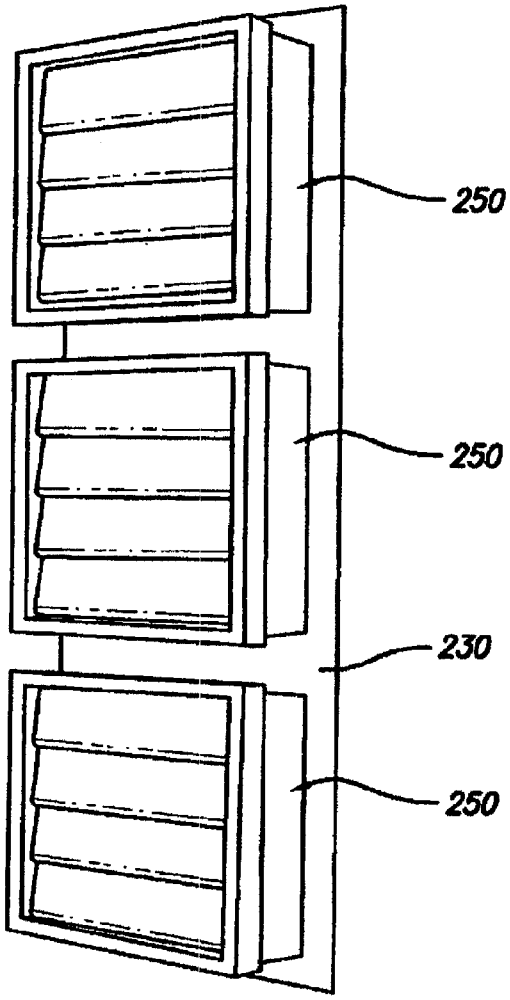

FIG. 18

FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS

The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Ser. No. 60/456,413, filed Mar. 20, 2003, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a continuation-in-part application of PCT Patent Application Serial Number PCT/US2004/008578, filed Mar. 19, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Ser. No. 60/554,702, filed Mar. 20, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is based on and claims priority from these applications, the disclosures of which are hereby expressly incorporated herein by reference.

BACKGROUND OF INVENTION

The present invention is directed to a fan array fan section utilized in an air-handling system.

Air-handling systems (also referred to as an air handler) have traditionally been used to condition buildings or rooms (hereinafter referred to as "structures"). An air-handling system is defined as a system that includes components designed to work together in order to condition air as part of the primary system for ventilation of structures. The air-handling system may contain components such as cooling coils, heating coils, filters, humidifiers, fans, sound attenuators, controls, and other devices functioning to meet the needs of the structures. The air-handling system may be manufactured in a factory and brought to the structure to be installed or it may be built on site using the necessary devices to meet the functioning needs of the structure. The air-handling compartment **102** of the air-handling system includes the inlet plenum **112** prior to the fan inlet cone **104** and the discharge plenum **110**. Within the air-handling compartment **102** is situated the fan unit **100** (shown in FIGS. 1 and 2 as an inlet cone **104**, a fan **106**, and a motor **108**), fan frame, and any appurtenance associated with the function of the fan (e.g. dampers, controls, settling means, and associated cabinetry). Within the fan **106** is a fan wheel (not shown) having at least one blade. The fan wheel has a fan wheel diameter that is measured from one side of the outer periphery of the fan wheel to the opposite side of the outer periphery of the fan wheel. The dimensions of the handling compartment **102** such as height, width, and airway length are determined by consulting fan manufacturers data for the type of fan selected.

FIG. 1 shows an exemplary prior art air-handling system having a single fan unit **100** housed in an air-handling compartment **102**. For exemplary purposes, the fan unit **100** is shown having an inlet cone **104**, a fan **106**, and a motor **108**. Larger structures, structures requiring greater air volume, or structures requiring higher or lower temperatures have generally needed a larger fan unit **100** and a generally correspondingly larger air-handling compartment **102**.

As shown in FIG. **1**, an air-handling compartment **102** is substantially divided into a discharge plenum **110** and an inlet plenum **112**. The combined discharge plenum **110** and the inlet plenum **112** can be referred to as the airway path **120**. The fan unit **100** may be situated in the discharge plenum **110** as shown), the inlet plenum **112**, or partially within the inlet plenum **112** and partially within the discharge plenum **110**. The portion of the airway path **120** in which the fan unit **100** is positioned may be generically referred to as the "fan section" (indicated by reference numeral **114**). The size of the inlet cone **104**, the size of the fan **106**, the size the motor **108**, and the size of the fan frame (not shown) at least partially determine the length of the airway path **120**. Filter banks **122** and/or cooling coils (not shown) may be added to the system either upstream or downstream of the fan units **100**.

For example, a first exemplary structure requiring 50,000 cubic feet per minute of air flow at six (6) inches water gage pressure would generally require a prior art air-handling compartment **102** large enough to house a 55 inch impeller, a 100 horsepower motor, and supporting framework. The prior art air-handling compartment **102**, in turn would be approximately 92 inches high by 114 to 147 inches wide and 106 to 112 inches long. The minimum length of the air-handling compartment **102** and/or airway path **120** would be dictated by published manufacturers data for a given fan type, motor size, and application. Prior art cabinet sizing guides show exemplary rules for configuring an air-handling compartment **102**. These rules are based on optimization, regulations, and experimentation.

For example, a second exemplary structure includes a recirculation air handler used in semiconductor and pharmaceutical clean rooms requiring 26,000 cubic feet per minute at two (2) inches water gage pressure. This structure would generally require a prior art air-handling system with a air-handling compartment **102** large enough to house a 44 inch impeller, a 25 horsepower motor, and supporting framework. The prior art air-handling compartment **102**, in turn would be approximately 78 inches high by 99 inches wide and 94 to 100 inches long. The minimum length of the air-handling compartment **102** and/or airway path **120** would be dictated by published manufacturers data for a given fan type, motor size and application. Prior art cabinet sizing guides show exemplary rules for configuring an air-handling compartment **102**. These rules are based on optimization, regulations, and experimentation.

These prior art air-handling systems have many problems including the following exemplary problems:

- Because real estate (e.g. structure space) is extremely expensive, the larger size of the air-handling compartment **102** is extremely undesirable.
- The single fan units **100** are expensive to produce and are generally custom produced for each job.
- Single fan units **100** are expensive to operate.
- Single fan units **100** are inefficient in that they only have optimal or peak efficiency over a small portion of their operating range.
- If a single fan unit **100** breaks down, there is no air conditioning at all.
- The low frequency sound of the large fan unit **100** is hard to attenuate.
- The high mass and turbulence of the large fan unit **100** can cause undesirable vibration.

Height restrictions have necessitated the use of air-handling systems built with two fan units **100** arranged horizontally adjacent to each other. It should be noted, however, that a good engineering practice is to design air handler cabinets and discharge plenums **110** to be symmetrical to facilitate more uniform air flow across the width and height of the cabinet. Twin fan units **100** have been utilized where there is a height restriction and the unit is designed with a high aspect ratio to accommodate the desired flow rate. As

shown in the Greenheck "Installation Operating and Maintenance Manual," if side-by-side installation was contemplated, there were specific instructions to arrange the fans such that there was at least one fan wheel diameter spacing between the fan wheels and at least one-half a fan wheel diameter between the fan and the walls or ceilings. The Greenheck reference even specifically states that arrangements "with less spacing will experience performance losses." Normally, the air-handling system and air-handling compartment **102** are designed for a uniform velocity gradient of **500** feet per minute velocity in the direction of air flow. The two fan unit **100** air-handling systems, however, still substantially suffered from the problems of the single unit embodiments. There was no recognition of advantages by increasing the number of fan units **100** from one to two. Further, the two fan unit **100** section exhibits a non-uniform velocity gradient in the region following the fan unit **100** that creates uneven air flow across filters, coils, and sound attenuators.

It should be noted that electrical devices have taken advantage of multiple fan cooling systems. For example, U.S. Pat. No. 6,414.845 to Bonet uses a multiple-fan modular cooling component for installation in multiple component-bay electronic devices. Although some of the advantages realized in the Bonet system would be realized in the present system, there are significant differences. For example, the Bonet system is designed to facilitate electronic component cooling by directing the output from each fan to a specific device or area. The Bonet system would not work to direct air flow to all devices in the direction of general air flow. Other patents such as U.S. Pat. No. 4,767, 262 to Simon and U.S. Pat. No. 6,388.880 to El-Ghobashy et al. teach fan arrays for use with electronics.

Even in the computer and machine industries, however, operating fans in parallel is taught against as not providing the desired results except in low system resistance situations where fans operate in near free delivery. For example, Sunon Group has a web page in which they show two axial fans operating in parallel, but specifically state that if "the parallel fans are applied to the higher system resistance that [an] enclosure has, . . . less increase in flow results with parallel fan operation." Similar examples of teaching against using fans in parallel are found in an article accessible from HighBeam Research's library (http://stati.highbeam.com) and an article by Ian McLeod accessible at (http://www-.papstplc.com).

BRIEF SUMMARY OF THE INVENTION

The present invention is directed to a fan array fan section in an air-handling system that includes a plurality of fan units arranged in a fan array and positioned within an air-handling compartment. One preferred embodiment may include an array controller programmed to operate the plurality of fan units at peak efficiency. The plurality of fan units may be arranged in a true array configuration, a spaced pattern array configuration, a checker board array configuration, rows slightly offset array configuration, columns slightly offset array configuration, or a staggered array configuration.

The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a side view of an exemplary prior art air-handling system having a single large fan unit within an air-handling compartment.

FIG. **2** is a perspective view of an exemplary prior art large fan unit.

FIG. **3** is a side view of an exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. **4** is a plan or elevation view of a 4x6 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. **5** is a plan or elevation view of a 5x5 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. **6** is a plan or elevation view of a 3x4 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. **7** is a plan or elevation view of a 3x3 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. **8** is a plan or elevation view of a 3x1 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. **9** is a plan or elevation view of an alternative exemplary fan array fan section in an air-handling system of the present invention in which a plurality of small fan units are arranged in a spaced pattern array within an air-handling compartment.

FIG. **10** is a plan or elevation view of an alternative exemplary fan array fan section in an air-handling system of the present invention in which a plurality of small fan units are arranged in a checker board array within an air-handling compartment.

FIG. **11** is a plan or elevation view of an alternative exemplary fan array fan section in an air-handling system of the present invention in which a plurality of small fan units are arranged in rows slightly offset array within an air-handling compartment.

FIG. **12** is a plan or elevation view of an alternative exemplary fan array fan section in an air-handling system of the present invention in which a plurality of small fan units are arranged in columns slightly offset array within an air-handling compartment.

FIG. **13** is a plan or elevation view of a 5x5 exemplary fan array fan section in an air-handling system of the present invention running at 52% capacity by turning a portion of the fans on and a portion of the fans off.

FIG. **14** is a plan or elevation view of a 5x5 exemplary fan array fan section in an air-handling system of the present invention running at 32% capacity by turning a portion of the fans on and a portion of the fans off.

FIG. **15** is a side view of an alternative exemplary fan array fan section in an air-handling system of the present invention having a plurality of staggered small fan units within an air-handling compartment.

FIG. **16** is a perspective view of an exemplary fan array using a grid system into which fan units are mounted.

FIG. **17** is a perspective view of an exemplary fan array using a grid system or modular units each of which includes a fan units mounted within its own fan unit chamber.

FIG. **18** is a perspective view of an exemplary array of dampeners that may be positioned either in front of or behind the fan units.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to a fan array fan section in an air-handling system. As shown in FIGS. **3–12**, the fan array fan section in the air-handling system uses a plurality of individual single fan units **200**. In one preferred embodiment, the fan units **200** are arranged in a true array (FIGS. **4–8**), but alternative embodiments may include, for example, alternative arrangements such as in a spaced pattern (FIG. **9**), a checker board (FIG. **10**), rows slightly offset (FIG. **11**), or columns slightly offset (FIG. **12**). As the present invention could be implemented with true arrays and/or alternative arrays, the term "array" is meant to be comprehensive.

The fan units **200** in the fan array of the present invention may be spaced as little as 20% of a fan wheel diameter. Optimum operating conditions for a closely arranged array may be found at distances as low as 30% to 60% of a fan wheel diameter. By closely spacing the fan units **200**, more air may be moved in a smaller space. For example, if the fan wheels of the fan units **200** have a 20 inch fan wheel diameter, only a 4 inch space (20%) is needed between the outer periphery of one fan wheel and the outer periphery of the adjacent fan wheel (or a 2 inch space between the outer periphery of a fan wheel and an the adjacent wall or ceiling).

By using smaller fan units **200** it is possible to support the fan units **200** with less intrusive structure (fan frame). This can be compared to the large fan frame that supports prior art fan units **100** and functions as a base. This large fan frame must be large and sturdy enough to support the entire weight of the prior art fan units **100**. Because of their size and position, the known fan frames cause interference with air flow. In the preferred embodiment, therefore, the fan units **200** of the fan array may be supported by a frame that supports the motors **108** with a minimum restriction to air flow.

As mentioned in the Background, others have tried using side-by-side installation of two fan units **100** arranged horizontally adjacent to each other within an air-handling system. As is also mentioned in the Background, fan arrays have been used in electronic and computer assemblies. However, in the air-handling system industry, it has always been held that there must be significant spacing between the horizontally arranged fan wheels and that arrangements with less spacing will experience performance losses. A single large fan moves all the air in a cabinet. Using two of the same or slightly smaller fans caused the air produced by one fan to interfere with the air produced by the other fan. To alleviate the interference problem, the fans had to be spaced within certain guidelines —generally providing a clear space between the fans of a distance of at least one wheel diameter (and a half a wheel diameter to an adjacent wall). Applying this logic, it would not have made sense to add more fans. And even if additional fans had been added, the spacing would have continued to be at least one wheel diameter between fans. Further, in the air-handling system industry, vertically stacking fan units would have been unthinkable because the means for securing the fan units would not have been conducive to such stacking (they are designed to be positioned on the floor only).

It should be noted that the plenum fan is the preferred fan unit **200** of the present invention. In particular, the APF-121, APF-141, APF-161, and APF-181 plenum fans (particularly the fan wheel and the fan cone) produced by Twin City Fan Companies, Ltd. of Minneapolis, Minn., U.S. has been found to work well. The reason that plenum fans work best is that they do not produce points of high velocity such as those produced by axial fans and housed centrifugal fans and large plenum fans. Alternative embodiments use known fan units or fan units yet to be developed that will not produce high velocity gradients in the direction of air flow. Still other embodiments, albeit less efficient, use fan units such as axial fans and/or centrifugal housed fans that have points of high velocity in the direction of air flow.

In the preferred embodiment, each of the fan units **200** in the fan array fan section in the air-handling system is controlled by an array controller **300** (FIGS. **13** and **14**). In one preferred embodiment, the array controller **300** may be programmed to operate the fan units **200** at peak efficiency. In this peak efficiency embodiment, rather than running all of the fan units **200** at a reduced efficiency, the array controller **300** turns off certain fan units **200** and runs the remaining fan units **200** at peak efficiency. In an alternative embodiment, the fan units **200** could all run at the same power level (e.g. efficiency and/or flow rate) of operation.

Another advantage of the present invention is that the array controller **300** (which may be a variable frequency drive (VFD)) used for controlling fan speed and thus flow rate and pressure, could be sized for the actual brake horsepower of the fan array fan section in the air-handling system. Since efficiency of the fan wall array can be optimized over a wide range of flow rates and pressures, the actual operating power consumed by the fan array is substantially less than the actual operating power consumed by the comparable prior art air-handling systems and the array controller's power could be reduced accordingly. The array controller **300** could be sized to the actual power consumption of the fan array where as the controller (which may have been a variable frequency drive) in a traditional design would be sized to the maximum nameplate rating of the motor per Electrical Code requirements. An example of a prior art fan design supplying 50,000 cubic feet per minute of air at 2.5 inches pressure, would require a 50 horsepower motor and 50 horsepower controller. The new invention will preferably use an array of fourteen 2 horsepower motors and a 30 horsepower array controller **300**.

This invention solves many of the problems of the prior art air-handling systems including, but not limited to real estate, reduced production costs, reduced operating expenses, increased efficiency, improved air flow uniformity, redundancy, sound attenuation advantages, and reduced vibration.

Controllability

As mentioned, preferably each of the fan units **200** in the fan array fan section in the air-handling system is controlled by an array controller **300** (FIGS. **13** and **14**) that may be programmed to operate the fan units **200** at peak efficiency. In this peak efficiency embodiment, rather than running all of the fan units **200** at a reduced efficiency, the array controller **300** is able to turn off certain fan units **200** and run the remaining fan units **200** at peak efficiency. Preferably,

the array controller **300** is able to control fan units **200** individually, in predetermined groupings, and/or as a group as a whole.

For example, in the 5x5 fan array such as that shown in FIGS. **5**, **13**, and **14**, a person desiring to control the array may select desired air volume, a level of air flow, a pattern of air flow, and/or how many fan units **200** to operate. Turning first to air volume, each fan unit **200** in a 5x5 array contributes 4% of the total air. In variable air volume systems, which is what most structures have, only the number of fan units **200** required to meet the demand would operate. A control system (that may include the array controller **300**) would be used to take fan units **200** on line (an "ON" fan unit **200**) and off line (an "OFF" fan unit **200**) individually. This ability to turn fan units **200** on and off could effectively eliminate the need for a variable frequency drive. Similarly, each fan unit **200** in a 5x5 array uses 4% of the total power and produces 4% of the level of air flow. Using a control system to take fan units **200** on line and off line allows a user to control power usage and/or air flow. The pattern of air flow can also be controlled if that would be desirable. For example, depending on the system it is possible to create a pattern of air flow only around the edges of a cabinet or air only at the top. Finally, individual fan units **200** may be taken on line and off line. This controllability may be advantageous if one or more fan units **200** are not working properly, need to be maintained (e.g. needs general service), and/or need to be replaced. The problematic individual fan units **200** may be taken off line while the remainder of the system remains fully functional. Once the individual fan units **200** are ready for use, they may be brought back on line.

A further advantage to taking fan units **200** on and off line occurs when building or structure control systems require low volumes of air at relatively high pressures. In this case, the fan units **200** could be modulated to produce a stable operating point and eliminate the surge effects that sometimes plague structure owners and maintenance staff. The surge effect is where the system pressure is too high for the fan speed at a given volume and the fan unit **200** has a tendency to go into stall.

Examples of controllability are shown in FIGS. **13** and **14**. In the fan array fan section in the air-handling system shown in FIG. **13**, the array controller **300** alternates "ON" fan units **200** and "OFF" fan units **200** in a first exemplary pattern as shown so that the entire system is set to operate at 52% of the maximum rated air flow but only consumes 32% of full rated power. These numbers are based on exemplary typical fan operations in a structure. FIG. **14** shows the fan array fan section in the air-handling system set to operate at 32% of the maximum rated air flow but only consumes 17% of full rated power. These numbers are based on exemplary typical fan operations in a structure. In this embodiment, the array controller **300** creates a second exemplary pattern of "OFF" fan units **200** and "ON" fan units **200** as shown.

Real Estate

The fan array fan section in the air-handling section **220** of the present invention preferably uses (60% to 80%) less real estate than prior art discharge plenums **120** (with the hundred series number being prior art as shown in FIG. **1** and the two hundred series number being the present invention as shown in FIG. **3**) in air-handling systems. Comparing the prior art (FIG. **1**) and the present invention (FIG. **3**) shows a graphical representation of this shortening of the airway path **120**, **220**. There are many reasons that using multiple smaller fan units **200** can reduce the length of the airway path **120**, **220**. For example, reducing the size of the fan unit **100**, **200** and motor **108**, **208** reduces the length of the discharge plenum **110**, **210**. Similarly, reducing the size of the inlet cone **104**,**204** reduces the length of the inlet plenum **112**, **212**. The length of the discharge plenum **110**, **210** can also be reduced because air from the fan array fan section in the air-handling system of the present invention is substantially uniform whereas the prior art air-handling system has points of higher air velocity and needs time and space to mix so that the flow is uniform by the time it exits the air-handling compartment **102**, **202**. (This can also be described as the higher static efficiency in that the present invention eliminates the need for settling means downstream from the discharge of a prior art fan system because there is little or no need to transition from high velocity to low velocity.) The fan array fan section in the air-handling system takes in air from the inlet plenum **212** more evenly and efficiently than the prior art air-handling system so that the length of the inlet plenum **112**, **212** may be reduced.

For purposes of comparison, the first exemplary structure set forth in the Background of the Invention (a structure requiring 50,000 cubic feet per minute of air flow at a pressure of six (6) inches water gage) will be used. Using the first exemplary structure, an exemplary embodiment of the present invention could be served by a nominal discharge plenum **210** of 89 inches high by 160 inches wide and 30 to 36 inches long (as compared to 106 to 112 inches long in the prior art embodiments). The discharge plenum **210** would include a 3x4 fan array fan section in the air-handling system such as the one shown in FIG. **6**) having 12 fan units **200**. The space required for each exemplary fan unit **200** would be a rectangular cube of approximately 24 to 30 inches on a side depending on the array configuration. The airway path **220** is 42 to 48 inches (as compared to 88 to 139 inches in the prior art embodiments).

For purposes of comparison, the second exemplary structure set forth in the Background of the Invention (a structure requiring 26,000 cubic feet per minute of air flow at a pressure of two (2) inches water gage) will be used. Using the second exemplary structure, an exemplary embodiment of the present invention could be served by a nominal discharge plenum **210** of 84 inches high by 84 inches wide, and and 30 to 36 inches long (as compared to 94 to 100 inches long in the prior art embodiments). The discharge plenum would include a 3x3 fan array fan section in the air-handling system (such as the one shown in FIG. **7**) having 9 fan units **200**. The space required for each exemplary fan unit **200** would be a rectangular cube of approximately 24 to 30 inches on a side depending on the array configuration. The airway path **220** is 42 to 48 inches (as compared to 71 to 95 inches in the prior art embodiments).

Reduced Production Costs

It is generally more cost effective to build the fan array fan section in the air-handling system of the present invention as compared to the single fan unit **100** used in prior art air-handling systems. Part of this cost savings may be due to the fact that individual fan units **200** of the fan array can be mass-produced. Part of this cost savings may be due to the fact that it is less expensive to manufacture smaller fan units **200**. Whereas the prior art single fan units **100** were generally custom built for the particular purpose, the present invention could be implemented on a single type of fan unit **200**. In alternative embodiments, there might be several fan units **200** having different sizes and/or powers (both input and output). The different fan units **200** could be used in a single air-handling system or each air-handling system

would have only one type of fan unit **200**. Even when the smaller fan units **200** are custom made, the cost of producing multiple fan units **200** for a particular project is almost always less that the cost of producing a single large prior art fan unit **100** for the same project. This may be because of the difficulties of producing the larger components and/or the cost of obtaining the larger components necessary for the single large prior art fan unit **100**. This cost savings also extends to the cost of producing a smaller air-handling compartment **202**.

In one preferred embodiment of the invention, the fan units **200** are modular such that the system is "plug and play." Such modular units may be implemented by including structure for interlocking on the exterior of the fan units **200** themselves. Alternatively, such modular units may be implemented by using separate structure for interlocking the fan units **200**. In still another alternative embodiment, such modular units may be implemented by using a grid system into which the fan units **200** may be placed.

Reduced Operating Expenses

The fan array fan section in the air-handling system of the present invention preferably are less expensive to operate than prior art air-handling systems because of greater flexibility of control and fine tuning to the operating requirements of the structure. Also, by using smaller higher speed fan units **200** that require less low frequency noise control and less static resistance to flow.

Increased Efficiency

The fan array fan section in the air-handling system of the present invention preferably is more efficient than prior art air-handling systems because each small fan unit **200** can run at peak efficiency. The system could turn individual fan units **200** on and off to prevent inefficient use of particular fan units **200**. It should be noted that an array controller **300** could be used to control the fan units **200**. As set forth above, the array controller **300** turns off certain fan units **200** and runs the remaining fan units **200** at peak efficiency.

Redundancy

Multiple fan units **200** add to the redundancy of the system. If a single fan unit **200** breaks down, there will still be cooling. The array controller **300** may take disabled fan units **200** into consideration such that there is no noticeable depreciation in cooling or air flow rate. This feature may also be useful during maintenance as the array controller **300** may turn off fan units **200** that are to be maintained offline with no noticeable depreciation in cooling or air flow rate.

Sound Attenuation Advantages

The high frequency sound of the small fan units **200** is easier to attenuate than the low frequency sound of the large fan unit. Because the fan wall has less low frequency sound energy, shorter less costly sound traps are needed to attenuate the higher frequency sound produced by the plurality of small fan units **200** than the low frequency sound produced by the single large fan unit **100**. The plurality of fan units **200** will each operate in a manner such that acoustic waves from each unit will interact to cancel sound at certain frequencies thus creating a quieter operating unit than prior art systems.

Reduced Vibration

The multiple fan units **200** of the present invention have smaller wheels with lower mass and create less force due to residual unbalance thus causing less vibration than the large fan unit. The overall vibration of multiple fan units **200** will transmit less energy to a structure since individual fans will tend to cancel each other due to slight differences in phase. Each fan unit **200** of the multiple fan units **200** manage a smaller percentage of the total air handling requirement and thus produce less turbulence in the air stream and substantially less vibration.

ALTERNATIVE EMBODIMENTS

As mentioned, in one preferred embodiment of the invention, the fan units **200** are modular such that the system is "plug and play." Such modular units may be implemented by including structure for interlocking on the exterior of the fan units **200** themselves. Alternatively, such modular units may be implemented by using separate structure for interlocking the fan units **200**. In still another alternative embodiment, such modular units may be implemented by using a grid system into which the fan units **200** may be placed.

FIG. **16** shows an embodiment using an exemplary grid system **230** into which the fan units **200** may be placed. In this embodiment the grid may be positioned and/or built within the air-handling compartment **202**. The fan units **200** may then be positioned into the grid openings. One advantage of this configuration is that individual fan units **200** may be easily removed, maintained, and/or replaced. This embodiment uses an exemplary unique motor mount **232** that supports the motor **208** without interfering with air flow therearound. As shown, this exemplary motor mount **232** has a plurality of arms that mount around the fan inlet cone **204**. It should be noted that the dimensions of the grid are meant to be exemplary. The grid may be constructed taking into consideration that the fan units **200** in the present invention may be spaced with as little as 20% of a fan wheel diameter between the fan units **200**.

FIG. **17** shows an embodiment using either a grid system or modular units **240** using separate structure (not shown) for interlocking the fan units **200**. In this exemplary embodiment, each of the fan units **200** are mounted on a more traditional motor mount **242** within its own fan unit chamber **244**. In one preferred embodiment, the fan unit **200** and motor mount **242** are preferably suspended within their own fan unit chamber **244** such that there is an air relief passage **246** therebelow. This air relieve passage **246** tends to improve air flow around the fan units **200**.

The fan unit chambers **244** shown in FIG. **17** may include one or more interior surface made from or lined with an acoustically absorptive material or "insulation surface" **248**. Going against conventional industry wisdom that surfaces cannot be placed in close proximity with the fan units **200**, the present invention places one or more insulation surfaces **248** at least partially around each fan unit **200** without disrupting air flow. The insulation surfaces **248** may include one or more of the sides, top, bottom, front, or back. Exemplary types of insulation include, but are not limited to traditional insulation board (such as that made from inorganic glass fibers (fiberglass) alone or with a factory-applied foil-scrim-kraft (FSK) facing or a factory-applied all service jacket (ASJ)) or alternative insulation such as open cell foam such as that disclosed in U.S. patent application Ser. No. 10/606,435, which is assigned to the assignee of the present invention, and which the disclosure of which is hereby incorporated by reference herein. Together, the insulation surfaces **248** on the fan unit chambers **244** tend to function as a coplanar silencer. Some of the benefits of using the coplanar silencer include (1) no added airway length for splitters, (2) no pressure drop, and/or (3) relatively low cost.

The acoustic advantages of this and other embodiments make the present invention ideal for use in concert halls, lecture halls, performing arts centers, libraries, hospitals, and other applications that are acoustically sensitive.

Although FIG. **17** shows the discharge plenum **210** positioned within the fan unit chambers **244**, alternative embodiments of fan unit chambers **244** could enclose the inlet plenum **212**, or at least partially enclose both the inlet plenum **212** and the discharge plenum **210**. Still other alternative embodiments of fan unit chambers **244** may have grid or wire surfaces (that increase the safety of the present invention) or be open (that would reduce costs).

FIG. **18** shows an array of dampeners **250** that may be positioned either in front of or behind the fan units **200** to at least partially prevent back drafts. In the shown exemplary embodiment, the dampeners **250** include a plurality of plates, each plate positioned on its own pivot. In the shown exemplary embodiment, the plurality of plates slightly overlap each other. The shown embodiment is constructed such that when air is flowing through the fan units **200**, the plates are in the open position and when the air stops, gravity pulls the plates into the closed position. Preferably, each of the dampeners **250** operates independently such that if some of the fan units **200** are ON and some of the fan units **200** are OFF, the dampeners **250** can open or close accordingly. Although shown as a simple mechanical embodiment, alternative embodiments could include structure that is controlled electronically and/or remotely from the dampeners **250**.

It should be noted that FIG. **4** shows a 4×6 fan array fan section in the air-handling system having twenty-four fan units **200**. FIG. **5** shows a 5×5 fan array fan section in the air-handling system having twenty-five fan units **200**. FIG. **6** shows a 3×4 fan array fan section in the air-handling system having twelve fan units **200**, FIG. **7** shows a 3×3 fan array fan section in the air-handling system having nine fan units **200**, and FIG. **8** shows a 3×1 fan array fan section in the air-handling system having three fan units **200**. It should be noted that the array may be of any size or dimension of more than two fan units **200**. It should be noted that although the fan units **200** may be arranged in a single plane (as shown in FIG. **3**), an alternative array configuration could contain a plurality of fan units **200** that are arranged in a staggered configuration (as shown in FIG. **15**) in multiple planes. It should be noted that cooling coils (not shown) could be added to the system either upstream or downstream of the fan units **200**. It should be noted that, although shown upstream from the fan units **200**, the filter bank **122**, **222** could be downstream.

It should be noted that an alternative embodiment would use a horizontally arranged fan array. In other words, the embodiments shown in FIGS. **3** **15** could be used horizontally or vertically or in any direction perpendicular to the direction of air flow. For example, if a vertical portion of air duct is functioning as the air-handling compartment **202**, the fan array may be arranged horizontally. This embodiment would be particularly practical in an air handling compartment for a return air shaft.

It should be noted that the fan section **214** may be any portion of the airway path **220** in which the fan units **200** are positioned. For example, the fan units **200** may be situated in the discharge plenum **210** (as shown), the inlet plenum **212**, or partially within the inlet plenum **212** and partially within the discharge plenum **210**. It should also be noted that the air-handling compartment **202** may be a section of air duct.

The terms and expressions that have been employed in the foregoing specification are used as terms of description and not of limitation, and are not intended to exclude equivalents of the features shown and described or portions of them. The scope of the invention is defined and limited only by the claims that follow.

What is claimed is:

1. A fan array fan section in an air-handling system comprising:

(a) at least six fan units;

(b) said at least six fan units arranged in a fan array;

(c) an air-handling compartment within which said fan array of fan units is positioned; and

(d) an array controller for controlling said at least six fan units to run at substantially peak efficiency by strategically turning selective ones of said at least six fan units on and off, wherein each fan unit has a peak efficiency operating range outside of which it operates at a reduced efficiency, and wherein said array controller is programmed to operate said at least six fan units at substantially peak efficiency by strategically turning off at least one fan unit operating at reduced efficiency and running the remaining fan units within said peak efficiency operating range.

2. The fan array fan section in an air-handling system of claim **1**, wherein said at least six fan units are plenum fans.

3. The fan array fan section in an air-handling system of **1**, wherein said air-handling compartment has an airway path, said airway path being less than 72 inches.

4. The fan array fan section in an air-handling system of claim **1**, wherein said at least six fan units are a plurality of fan units arranged in a fan array configuration selected from the group consisting of:

(a) a true array configuration;

(b) a spaced pattern array configuration;

(c) a checker board array configuration;

(d) rows slightly offset array configuration;

(e) columns slightly offset array configuration; and

(f) a staggered array configuration.

5. The fan array fan section in an air-handling system of claim **1**, wherein said at least six fan units include at least two vertically arranged fan units.

6. The fan array fan section in an air-handling system of claim **1**, wherein each of said at least six fan units is positioned within a fan unit chamber.

7. The fan array fan section in an air-handling system of claim **1**, wherein each of said at least six fan units is suspended within a respective said fan unit chamber such that there is an air relief passage there below.

8. The fan array fan section in an air-handling system of claim **1**, wherein each of said at least six fan units is positioned within a fan unit chamber having at least one acoustically absorptive insulation surface.

9. The fan array fan section in an air-handling system of claim **1**, wherein each of said at least six fan units are mounted in a grid system.

10. The fan array fan section in an air-handling system of claim **1**, wherein each of said at least six fan units has a fan wheel diameter, wherein spacing between said at least six fan units is less than 60% of said fan wheel diameter.

11. The fan array fan section in an air-handling system of claim **1**, further comprising an array of backdraft dampeners, each backdraft damponer in line with a respective fan unit.

12. The fan array fan section in an air-handling system of claim **1**, said array controller is programmed to operate said

at least six fan units at peak efficiency for a performance level based on a criteria selected from the following group of criteria:

(a) air volume;

(b) level of air flow;

(c) pattern of air flow; and

(d) number of fan units to operate.

13. The fan array fan section in an air-handling system of claim **1**, said array controller is programmed to operate said at least six fan units to produce a stable operating point and eliminate the surge effects.

14. The fan array fan section in an air-handling system of claim **1**, said array controller is programmed to selectively control the speed of each of said at least six fan units to run at substantially peak efficiency.

15. The fan array fan section in an air-handling system of claim **1**, said air-handling compartment positionable within a structure such that said air-handling system conditions the air of said structure.

16. A fan array fan section in an air-handling system comprising:

(a) a plurality of independently controllable fan units, each fan unit comprising an inlet cone, a fan, and a motor;

(b) said plurality of fan units arranged in a fan array;

(c) an air-handling compartment within which said fan array of fan units is positioned;

(d) an array controller for controlling said plurality of fan units to run at substantially peak efficiency by strategically turning selective ones of said plurality of fan units on and off; wherein

(e) each of said plurality of fan units has a fan wheel diameter, wherein spacing between said pluality of fan units is less than 60% of said fan wheel diameter.

17. The fan array fan section in an air-handling system of claim **16**, wherein said plurality of fan units are plenum fans.

18. The fan array fan section in an air-handling system of claim **16**, wherein said air-handling compartment has an airway path, said airway path being less than 72 inches.

19. The fan array fan section in an air-handling system of claim **16**, wherein said plurality of fan units are a plurality of fan units arranged in a fan array configuration selected from the group consisting of:

(a) a true array configuration;

(b) a spaced pattern array configuration;

(c) a checker board array configuration;

(d) rows slightly offset array configuration;

(e) columns slightly offset array configuration; and

(f) a staggered array configuration.

20. The fan array fan section in an air-handling system of claim **16**, wherein said plurality of fan units include at least two vertically arranged fan units.

21. The fan array fan section in an air-handling system of claim **16**, wherein each of said plurality of fan units is positioned within a fan unit chamber.

22. The fan array fan section in an air-handling system of claim **16**, wherein each of said plurality of fan units is suspended within a respective said fan unit chamber such that there is an air relief passage therebelow.

23. The fan array fan section in an air-handling system of claim **16**, wherein each of said plurality of fan units is positioned within a fan unit chamber having at least one acoustically absorptive insulation surface.

24. The fan array fan section in an air-handling system of claim **16**, wherein each of said plurality of fan units is mounted in a grid system.

25. The fan array fan section in an air-handling system of claim **16**, further comprising an array of backdraft dampeners, each backdraft dampener in line with a respective fan unit.

26. The fan array fan section in an air-handling system of claim **16**, wherein each fan unit has a peak efficiency operating range outside of which it operates at a reduced efficiency, wherein said array controller is programmed to operate said plurality of fan units at substantially peak efficiency by strategically turning off at least one fan unit operating at reduced efficiency and running the remaining fan units within said peak efficiency operating range.

27. The fan array fan section in an air-handling system of claim **16**, said array controller is programmed to operate said plurality of fan units at peak efficiency for a performance level based on a criteria selected from the following group of criteria:

(a) air volume;

(b) level of air flow;

(c) pattern of air flow; and

(d) number of fan units to operate.

28. The fan array fan section in an air-handling system of claim **16**, said array controller is programmed to operate said plurality of fan units to produce a stable operating point and eliminate the surge effects.

29. The fan array fan section in an air-handling system of claim **16**, said array controller is programmed to selectively control the speed of each of said plurality of fan units to run at substantially peak efficiency.

30. The fan array fan section in an air-handling system of claim **16**, said air-handling compartment positionable within a structure such that said air-handling system conditions the air of said structure.

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PATENT APPLICATION SERIAL NO _____

U.S. DEPARTMENT OF COMMERCE
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FEE RECORD SHEET

03/25/2004 NDELETE1 00000004 10806775
01 FC:2001 385.00 OP

PTO-1556
(5/87)

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BIBDATASHEET

Bib Data Sheet

CONFIRMATION NO. 2371

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/806,775	03/22/2004 RULE	415	3745	Hunt:FanArr1

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** CONTINUING DATA **********

This appln claims benefit of 60/456,413 03/20/2003
and claims benefit of 60/554,702 03/20/2004
and is a CIP of PCT/US04/08578 03/19/2004

** FOREIGN APPLICATIONS ********** None

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** 06/08/2004

Foreign Priority claimed	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ yes ☑ no 35 USC 119 (a-d) conditions met ☐ yes ☑ no ☐ Met after Allowance Verified and Acknowledged _____ Examiner's Signature _____ Initials	OR	OR 15	20	2

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TITLE
Fan array fan section in air-handling systems

FILING FEE	FEES: Authority has been given in Paper	
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FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS

ABSTRACT OF THE DISCLOSURE

A fan array fan section in an air-handling system includes a plurality of fan units arranged in a fan array and positioned within an air-handling compartment. One preferred embodiment may include an array controller programmed to operate the plurality of fan units at peak efficiency. The plurality of fan units may be arranged in a true array configuration, a spaced pattern array configuration, a checker board array configuration, rows slightly offset array configuration, columns slightly offset array configuration, or a staggered array configuration.

Express Mail No. EU122438309US

FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS

The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number 60/456,413, filed March 20, 2003, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a continuation-in-part application of PCT Patent Application Serial Number _____, filed March 19, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number _____, filed March 20, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is based on and claims priority from these applications, the disclosures of which are hereby expressly incorporated herein by reference.

BACKGROUND OF INVENTION

The present invention is directed to a fan array fan section utilized in an air-handling system.

Air-handling systems (also referred to as an air handler) have traditionally been used to condition buildings or rooms (hereinafter referred to as "structures"). An air-handling system is defined as a structure that includes components designed to work together in order to condition air as part of the primary system for ventilation of structures. The air-handling system may contain components such as cooling coils, heating coils, filters, humidifiers, fans, sound attenuators, controls, and other devices functioning to meet the needs of the structures. The air-handling system may be manufactured in a factory and brought to the structure to be installed or it may be built on site using the necessary devices to meet the functioning needs of the structure. The air-handling compartment 102 of the air-handling system includes the inlet plenum 112 prior to the fan inlet cone 104 and the discharge plenum 110. Within the air-handling compartment 102 is situated the fan unit 100 (shown in FIGS. 1 and 2 as an inlet cone 104, a fan 106, and a motor 108), fan frame, and any appurtenance associated with the function of the fan (e.g. dampers, controls, settling means, and associated cabinetry). Within the fan 106 is a fan wheel (not shown) having at least one blade. The fan wheel has a fan wheel diameter that is measured from one side of the outer periphery of the fan wheel to the opposite side of the outer periphery of the fan wheel. The dimensions of the handling compartment 102 such as height, width, and airway length are determined by consulting fan manufacturers data for the type of fan selected.

FIG. 1 shows an exemplary prior art air-handling system having a single fan unit 100 housed in an air-handling compartment 102. For exemplary purposes, the fan unit 100 is shown having an inlet cone 104, a fan 106, and a motor 108. Larger structures, structures requiring greater air volume, or structures requiring higher or lower temperatures have generally needed a larger fan unit 100 and a generally correspondingly larger air-handling compartment 102.

As shown in FIG. 1, an air-handling compartment 102 is substantially divided into a discharge plenum 110 and an inlet plenum 112. The combined discharge

plenum 110 and the inlet plenum 112 can be referred to as the airway path 120. The fan unit 100 may be situated in the discharge plenum 110 as shown), the inlet plenum 112, or partially within the inlet plenum 112 and partially within the discharge plenum 110. The portion of the airway path 120 in which the fan unit 100 is positioned may be generically referred to as the "fan section" (indicated by reference numeral 114). The size of the inlet cone 104, the size of the fan 106, the size the motor 108, and the size of the fan frame (not shown) at least partially determine the length of the airway path 120. Filter banks 122 and/or cooling coils (not shown) may be added to the system either upstream or downstream of the fan units 100.

For example, a first exemplary structure requiring 50,000 cubic feet per minute of air flow at six (6) inches water gage pressure would generally require a prior art air-handling compartment 102 large enough to house a 55 inch impeller, a 100 horsepower motor, and supporting framework. The prior art air-handling compartment 102, in turn would be approximately 92 inches high by 114 to147 inches wide and 106 to 112 inches long. The minimum length of the air-handling compartment 102 and/or airway path 120 would be dictated by published manufacturers data for a given fan type, motor size, and application. Prior art cabinet sizing guides show exemplary rules for configuring an air-handling compartment 102. These rules are based on optimization, regulations, and experimentation.

For example, a second exemplary structure includes a recirculation air handler used in semiconductor and pharmaceutical clean rooms requiring 26,000 cubic feet per minute at two (2) inches water gage pressure. This structure would generally require a prior art air-handling system with a air-handling compartment 102 large enough to house a 44 inch impeller, a 25 horsepower motor, and supporting framework. The prior art air-handling compartment 102, in turn would be approximately 78 inches high by 99 inches wide and 94 to 100 inches long. The minimum length of the air-handling compartment 102 and/or airway path 120 would be dictated by published manufacturers data for a given fan type, motor size and application. Prior art cabinet sizing guides show exemplary rules for configuring an air-handling compartment 102. These rules are based on optimization, regulations, and experimentation.

These prior art air-handling systems have many problems including the following exemplary problems:

- Because real estate (e.g. structure space) is extremely expensive, the larger size of the air-handling compartment 102 is extremely undesirable.
- The single fan units 100 are expensive to produce and are generally custom produced for each job.
- Single fan units 100 are expensive to operate.
- Single fan units 100 are inefficient in that they only have optimal or peak efficiency over a small portion of their operating range.
- If a single fan unit 100 breaks down, there is no air conditioning at all.
- The low frequency sound of the large fan unit 100 is hard to attenuate.
- The high mass and turbulence of the large fan unit 100 can cause undesirable vibration.

Height restrictions have necessitated the use of air-handling systems built with two fan units 100 arranged horizontally adjacent to each other. It should be noted, however, that a good engineering practice is to design air handler cabinets and discharge plenums 110 to be symmetrical to facilitate more uniform air flow across the width and height of the cabinet. Twin fan units 100 have been utilized where there is a height restriction and the unit is designed with a high aspect ratio to accommodate the desired flow rate. As shown in the Greenheck "Installation Operating and Maintenance Manual," if side-by-side installation was contemplated, there were specific instructions to arrange the fans such that there was at least one fan wheel diameter spacing between the fan wheels and at least one-half a fan wheel diameter between the fan and the walls or ceilings. The Greenheck reference even specifically states that arrangements "with less spacing will experience performance losses." Normally, the air-handling system and air-handling compartment 102 are designed for a uniform velocity gradient of 500 feet per minute velocity in the direction of air flow. The two fan unit 100

air-handling systems, however, still substantially suffered from the problems of the single unit embodiments. There was no recognition of advantages by increasing the number of fan units 100 from one to two. Further, the two fan unit 100 section exhibits a non-uniform velocity gradient in the region following the fan unit 100 that creates uneven air flow across filters, coils, and sound attenuators.

It should be noted that electrical devices have taken advantage of multiple fan cooling systems. For example, U.S. Patent No. 6,414,845 to Bonet uses a multiple-fan modular cooling component for installation in multiple component-bay electronic devices. Although some of the advantages realized in the Bonet system would be realized in the present system, there are significant differences. For example, the Bonet system is designed to facilitate electronic component cooling by directing the output from each fan to a specific device or area. The Bonet system would not work to direct air flow to all devices in the direction of general air flow. Other patents such as U.S. Patent No. 4,767,262 to Simon and U.S. Patent No. 6,388,880 to El-Ghobashy et al. teach fan arrays for use with electronics.

Even in the computer and machine industries, however, operating fans in parallel is taught against as not providing the desired results except in low system resistance situations where fans operate in near free delivery. For example, Sunon Group has a web page in which they show two axial fans operating in parallel, but specifically state that if "the parallel fans are applied to the higher system resistance that [an] enclosure has, . . . less increase in flow results with parallel fan operation." Similar examples of teaching against using fans in parallel are found in an article accessible from HighBeam Research's library (http://stati.highbeam.com) and an article by Ian McLeod accessible at (http://www.papstplc.com).

BRIEF SUMMARY OF THE INVENTION

The present invention is directed to a fan array fan section in an air-handling system that includes a plurality of fan units arranged in a fan array and positioned within an air-handling compartment. One preferred embodiment may include an array controller programmed to operate the plurality of fan units at peak efficiency. The plurality of fan units may be arranged in a true array configuration, a spaced pattern array configuration, a checker board array configuration, rows slightly offset array configuration, columns slightly offset array configuration, or a staggered array configuration.

The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a side view of an exemplary prior art air-handling system having a single large fan unit within an air-handling compartment.

FIG. 2 is a perspective view of an exemplary prior art large fan unit.

FIG. 3 is a side view of an exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. 4 is a plan or elevation view of a 4x6 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. 5 is a plan or elevation view of a 5x5 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. 6 is a plan or elevation view of a 3x4 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. 7 is a plan or elevation view of a 3x3 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. 8 is a plan or elevation view of a 3x1 exemplary fan array fan section in an air-handling system of the present invention having a plurality of small fan units within an air-handling compartment.

FIG. 9 is a plan or elevation view of an alternative exemplary fan array fan section in an air-handling system of the present invention in which a plurality of small fan units are arranged in a spaced pattern array within an air-handling compartment.

FIG. 10 is a plan or elevation view of an alternative exemplary fan array fan section in an air-handling system of the present invention in which a plurality of small fan units are arranged in a checker board array within an air-handling compartment.

FIG. 11 is a plan or elevation view of an alternative exemplary fan array fan section in an air-handling system of the present invention in which a plurality of small fan units are arranged in rows slightly offset array within an air-handling compartment.

FIG. 12 is a plan or elevation view of an alternative exemplary fan array fan section in an air-handling system of the present invention in which a plurality of small fan units are arranged in columns slightly offset array within an air-handling compartment.

FIG. 13 is a plan or elevation view of a 5x5 exemplary fan array fan section in an air-handling system of the present invention running at 52% capacity by turning a portion of the fans on and a portion of the fans off.

FIG. 14 is a plan or elevation view of a 5x5 exemplary fan array fan section in an air-handling system of the present invention running at 32% capacity by turning a portion of the fans on and a portion of the fans off.

FIG. 15 is a side view of an alternative exemplary fan array fan section in an air-handling system of the present invention having a plurality of staggered small fan units within an air-handling compartment.

FIG. 16 is a perspective view of an exemplary fan array using a grid system into which fan units are mounted.

FIG. 17 is a perspective view of an exemplary fan array using a grid system or modular units each of which includes a fan units mounted within its own fan unit chamber.

FIG. 18 is a perspective view of an exemplary array of dampeners that may be positioned either in front of or behind the fan units.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to a fan array fan section in an air-handling system. As shown in FIGS. 3-12, the fan array fan section in the air-handling system uses a plurality of individual single fan units 200. In one preferred embodiment, the fan units 200 are arranged in a true array (FIGS. 4-8), but alternative embodiments may include, for example, alternative arrangements such as in a spaced pattern (FIG. 9), a checker board (FIG. 10), rows slightly offset (FIG. 11), or columns slightly offset (FIG. 12). As the present invention could be implemented with true arrays and/or alternative arrays, the term "array" is meant to be comprehensive.

The fan units 200 in the fan array of the present invention may be spaced as little as 20% of a fan wheel diameter. Optimum operating conditions for a closely arranged array may be found at distances as low as 30% to 60% of a fan wheel diameter. By closely spacing the fan units 200, more air may be moved in a smaller space. For example, if the fan wheels of the fan units 200 have a 20 inch fan wheel diameter, only a 4 inch space (20%) is needed between the outer periphery of one fan wheel and the outer periphery of the adjacent fan wheel (or a 2 inch space between the outer periphery of a fan wheel and an the adjacent wall or ceiling).

By using smaller fan units 200 it is possible to support the fan units 200 with less intrusive structure (fan frame). This can be compared to the large fan frame that supports prior art fan units 100 and functions as a base. This large fan frame must be large and sturdy enough to support the entire weight of the prior art fan units 100. Because of their size and position, the known fan frames cause interference with air flow. In the preferred embodiment, therefore, the fan units 200 of the fan array may be supported by a frame that supports the motors 108 with a minimum restriction to air flow.

As mentioned in the Background, others have tried using side-by-side installation of two fan units 100 arranged horizontally adjacent to each other within an air-handling system. As is also mentioned in the Background, fan arrays have been used in electronic and computer assemblies. However, in the air-handling system industry, it has always been held that there must be significant spacing between the

horizontally arranged fan wheels and that arrangements with less spacing will experience performance losses. A single large fan moves all the air in a cabinet. Using two of the same or slightly smaller fans caused the air produced by one fan to interfere with the air produced by the other fan. To alleviate the interference problem, the fans had to be spaced within certain guidelines -- generally providing a clear space between the fans of a distance of at least one wheel diameter (and a half a wheel diameter to an adjacent wall). Applying this logic, it would not have made sense to add more fans. And even if additional fans had been added, the spacing would have continued to be at least one wheel diameter between fans. Further, in the air-handling system industry, vertically stacking fan units would have been unthinkable because the means for securing the fan units would not have been conducive to such stacking (they are designed to be positioned on the floor only).

It should be noted that the plenum fan is the preferred fan unit 200 of the present invention. In particular, the APF-121, APF-141, APF-161, and APF-181 plenum fans (particularly the fan wheel and the fan cone) produced by Twin City Fan Companies, Ltd. of Minneapolis, Minnesota, U.S. has been found to work well. The reason that plenum fans work best is that they do not produce points of high velocity such as those produced by axial fans and housed centrifugal fans and large plenum fans. Alternative embodiments use known fan units or fan units yet to be developed that will not produce high velocity gradients in the direction of air flow. Still other embodiments, albeit less efficient, use fan units such as axial fans and/or centrifugal housed fans that have points of high velocity in the direction of air flow.

In the preferred embodiment, each of the fan units 200 in the fan array fan section in the air-handling system is controlled by an array controller 300 (FIGS. 13 and 14). In one preferred embodiment, the array controller 300 may be programmed to operate the fan units 200 at peak efficiency. In this peak efficiency embodiment, rather than running all of the fan units 200 at a reduced efficiency, the array controller 300 turns off certain fan units 200 and runs the remaining fan units 200 at peak efficiency. In an alternative embodiment, the fan units 200 could all run at the same power level (e.g. efficiency and/or flow rate) of operation.

Another advantage of the present invention is that the array controller 300 (which may be a variable frequency drive (VFD)) used for controlling fan speed and thus flow rate and pressure, could be sized for the actual brake horsepower of the fan array fan section in the air-handling system. Since efficiency of the fan wall array can be optimized over a wide range of flow rates and pressures, the actual operating power consumed by the fan array is substantially less than the actual operating power consumed by the comparable prior art air-handling systems and the array controller's power could be reduced accordingly. The array controller 300 could be sized to the actual power consumption of the fan array where as the controller (which may have been a variable frequency drive) in a traditional design would be sized to the maximum nameplate rating of the motor per Electrical Code requirements. An example of a prior art fan design supplying 50,000 cubic feet per minute of air at 2.5 inches pressure, would require a 50 horsepower motor and 50 horsepower controller. The new invention will preferably use an array of fourteen 2 horsepower motors and a 30 horsepower array controller 300.

This invention solves many of the problems of the prior art air-handling systems including, but not limited to real estate, reduced production costs, reduced operating expenses, increased efficiency, improved air flow uniformity, redundancy, sound attenuation advantages, and reduced vibration.

Controllability

As mentioned, preferably each of the fan units 200 in the fan array fan section in the air-handling system is controlled by an array controller 300 (FIGS. 13 and 14) that may be programmed to operate the fan units 200 at peak efficiency. In this peak efficiency embodiment, rather than running all of the fan units 200 at a reduced efficiency, the array controller 300 is able to turn off certain fan units 200 and run the remaining fan units 200 at peak efficiency. Preferably, the array controller 300 is able to control fan units 200 individually, in predetermined groupings, and/or as a group as a whole.

For example, in the 5x5 fan array such as that shown in FIGS. 5, 13, and 14, a person desiring to control the array may select desired air volume, a level of air flow, a pattern of air flow, and/or how many fan units 200 to operate. Turning first to air volume, each fan unit 200 in a 5x5 array contributes 4% of the total air. In variable air volume systems, which is what most structures have, only the number of fan units 200 required to meet the demand would operate. A control system (that may include the array controller 300) would be used to take fan units 200 on line (an "ON" fan unit 200) and off line (an "OFF" fan unit 200) individually. This ability to turn fan units 200 on and off could effectively eliminate the need for a variable frequency drive. Similarly, each fan unit 200 in a 5x5 array uses 4% of the total power and produces 4% of the level of air flow. Using a control system to take fan units 200 on line and off line allows a user to control power usage and/or air flow. The pattern of air flow can also be controlled if that would be desirable. For example, depending on the system it is possible to create a pattern of air flow only around the edges of a cabinet or air only at the top. Finally, individual fan units 200 may be taken on line and off line. This controllability may be advantageous if one or more fan units 200 are not working properly, need to be maintained (e.g. needs general service), and/or need to be replaced. The problematic individual fan units 200 may be taken off line while the remainder of the system remains fully functional. Once the individual fan units 200 are ready for use, they may be brought back on line.

A further advantage to taking fan units 200 on and off line occurs when building or structure control systems require low volumes of air at relatively high pressures. In this case, the fan units 200 could be modulated to produce a stable operating point and eliminate the surge effects that sometimes plague structure owners and maintenance staff. The surge effect is where the system pressure is too high for the fan speed at a given volume and the fan unit 200 has a tendency to go into stall.

Examples of controllability are shown in FIGS. 13 and 14. In the fan array fan section in the air-handling system shown in FIG. 13, the array controller 300 alternates "ON" fan units 200 and "OFF" fan units 200 in a first exemplary pattern as shown so that the entire system is set to operate at 52% of the maximum rated air flow

but only consumes 32% of full rated power. These numbers are based on exemplary typical fan operations in a structure. FIG. 14 shows the fan array fan section in the air-handling system set to operate at 32% of the maximum rated air flow but only consumes 17% of full rated power. These numbers are based on exemplary typical fan operations in a structure. In this embodiment, the array controller 300 creates a second exemplary pattern of "OFF" fan units 200 and "ON" fan units 200 as shown.

Real Estate

The fan array fan section in the air-handling section 220 of the present invention preferably uses (60% to 80%) less real estate than prior art discharge plenums 120 (with the hundred series number being prior art as shown in FIG. 1 and the two hundred series number being the present invention as shown in FIG. 3) in air-handling systems. Comparing the prior art (FIG. 1) and the present invention (FIG. 3) shows a graphical representation of this shortening of the airway path 120, 220. There are many reasons that using multiple smaller fan units 200 can reduce the length of the airway path 120, 220. For example, reducing the size of the fan unit 100, 200 and motor 108, 208 reduces the length of the discharge plenum 110, 210. Similarly, reducing the size of the inlet cone 104, 204 reduces the length of the inlet plenum 112, 212. The length of the discharge plenum 110, 210 can also be reduced because air from the fan array fan section in the air-handling system of the present invention is substantially uniform whereas the prior art air-handling system has points of higher air velocity and needs time and space to mix so that the flow is uniform by the time it exits the air-handling compartment 102, 202. (This can also be described as the higher static efficiency in that the present invention eliminates the need for settling means downstream from the discharge of a prior art fan system because there is little or no need to transition from high velocity to low velocity.) The fan array fan section in the air-handling system takes in air from the inlet plenum 212 more evenly and efficiently than the prior art air-handling system so that the length of the inlet plenum 112, 212 may be reduced.

For purposes of comparison, the first exemplary structure set forth in the Background of the Invention (a structure requiring 50,000 cubic feet per minute of air flow at a pressure of six (6) inches water gage) will be used. Using the first exemplary structure, an exemplary embodiment of the present invention could be served by a nominal discharge plenum 210 of 89 inches high by 160 inches wide and 30 to 36 inches long (as compared to 106 to 112 inches long in the prior art embodiments). The discharge plenum 210 would include a 3x4 fan array fan section in the air-handling system such as the one shown in FIG. 6) having 12 fan units 200. The space required for each exemplary fan unit 200 would be a rectangular cube of approximately 24 to 30 inches on a side depending on the array configuration. The airway path 220 is 42 to 48 inches (as compared to 88 to 139 inches in the prior art embodiments).

For purposes of comparison, the second exemplary structure set forth in the Background of the Invention (a structure requiring 26,000 cubic feet per minute of air flow at a pressure of two (2) inches water gage) will be used. Using the second exemplary structure, an exemplary embodiment of the present invention could be served by a nominal discharge plenum 210 of 84 inches high by 84 inches wide, and and 30 to 36 inches long (as compared to 94 to 100 inches long in the prior art embodiments). The discharge plenum would include a 3x3 fan array fan section in the air-handling system (such as the one shown in FIG. 7) having 9 fan units 200. The space required for each exemplary fan unit 200 would be a rectangular cube of approximately 24 to 30 inches on a side depending on the array configuration. The airway path 220 is 42 to 48 inches (as compared to 71 to 95 inches in the prior art embodiments).

Reduced Production Costs

It is generally more cost effective to build the fan array fan section in the air-handling system of the present invention as compared to the single fan unit 100 used in prior art air-handling systems. Part of this cost savings may be due to the fact that individual fan units 200 of the fan array can be mass-produced. Part of this cost savings may be due to the fact that it is less expensive to manufacture smaller fan units

200. Whereas the prior art single fan units 100 were generally custom built for the particular purpose, the present invention could be implemented on a single type of fan unit 200. In alternative embodiments, there might be several fan units 200 having different sizes and/or powers (both input and output). The different fan units 200 could be used in a single air-handling system or each air-handling system would have only one type of fan unit 200. Even when the smaller fan units 200 are custom made, the cost of producing multiple fan units 200 for a particular project is almost always less that the cost of producing a single large prior art fan unit 100 for the same project. This may be because of the difficulties of producing the larger components and/or the cost of obtaining the larger components necessary for the single large prior art fan unit 100. This cost savings also extends to the cost of producing a smaller air-handling compartment 202.

In one preferred embodiment of the invention, the fan units 200 are modular such that the system is "plug and play." Such modular units may be implemented by including structure for interlocking on the exterior of the fan units 200 themselves. Alternatively, such modular units may be implemented by using separate structure for interlocking the fan units 200. In still another alternative embodiment, such modular units may be implemented by using a grid system into which the fan units 200 may be placed.

Reduced Operating Expenses

The fan array fan section in the air-handling system of the present invention preferably are less expensive to operate than prior art air-handling systems because of greater flexibility of control and fine tuning to the operating requirements of the structure. Also, by using smaller higher speed fan units 200 that require less low frequency noise control and less static resistance to flow.

Increased Efficiency

The fan array fan section in the air-handling system of the present invention preferably is more efficient than prior art air-handling systems because each

small fan unit 200 can run at peak efficiency. The system could turn individual fan units 200 on and off to prevent inefficient use of particular fan units 200. It should be noted that an array controller 300 could be used to control the fan units 200. As set forth above, the array controller 300 turns off certain fan units 200 and runs the remaining fan units 200 at peak efficiency.

Redundancy

Multiple fan units 200 add to the redundancy of the system. If a single fan unit 200 breaks down, there will still be cooling. The array controller 300 may take disabled fan units 200 into consideration such that there is no noticeable depreciation in cooling or air flow rate. This feature may also be useful during maintenance as the array controller 300 may turn off fan units 200 that are to be maintained offline with no noticeable depreciation in cooling or air flow rate.

Sound Attenuation Advantages

The high frequency sound of the small fan units 200 is easier to attenuate than the low frequency sound of the large fan unit. Because the fan wall has less low frequency sound energy, shorter less costly sound traps are needed to attenuate the higher frequency sound produced by the plurality of small fan units 200 than the low frequency sound produced by the single large fan unit 100. The plurality of fan units 200 will each operate in a manner such that acoustic waves from each unit will interact to cancel sound at certain frequencies thus creating a quieter operating unit than prior art systems.

Reduced Vibration

The multiple fan units 200 of the present invention have smaller wheels with lower mass and create less force due to residual unbalance thus causing less vibration than the large fan unit. The overall vibration of multiple fan units 200 will transmit less energy to a structure since individual fans will tend to cancel each other due to slight differences in phase. Each fan unit 200 of the multiple fan units 200

manage a smaller percentage of the total air handling requirement and thus produce less turbulence in the air stream and substantially less vibration.

Alternative Embodiments

As mentioned, in one preferred embodiment of the invention, the fan units 200 are modular such that the system is "plug and play." Such modular units may be implemented by including structure for interlocking on the exterior of the fan units 200 themselves. Alternatively, such modular units may be implemented by using separate structure for interlocking the fan units 200. In still another alternative embodiment, such modular units may be implemented by using a grid system into which the fan units 200 may be placed.

FIG. 16 shows an embodiment using an exemplary grid system 230 into which the fan units 200 may be placed. In this embodiment the grid may be positioned and/or built within the air-handling compartment 202. The fan units 200 may then be positioned into the grid openings. One advantage of this configuration is that individual fan units 200 may be easily removed, maintained, and/or replaced. This embodiment uses an exemplary unique motor mount 232 that supports the motor 208 without interfering with air flow therearound. As shown, this exemplary motor mount 232 has a plurality of arms that mount around the fan inlet cone 204. It should be noted that the dimensions of the grid are meant to be exemplary. The grid may be constructed taking into consideration that the fan units 200 in the present invention may be spaced with as little as 20% of a fan wheel diameter between the fan units 200.

FIG. 17 shows an embodiment using either a grid system or modular units 240 using separate structure (not shown) for interlocking the fan units 200. In this exemplary embodiment, each of the fan units 200 are mounted on a more traditional motor mount 242 within its own fan unit chamber 244. In one preferred embodiment, the fan unit 200 and motor mount 242 are preferably suspended within their own fan unit chamber 244 such that there is an air relief passage 246 therebelow. This air relieve passage 246 tends to improve air flow around the fan units 200.

The fan unit chambers 244 shown in FIG. 17 may include one ore more interior surface made from or lined with an acoustically absorptive material or "insulation surface" 248. Going against conventional industry wisdom that surfaces cannot be placed in close proximity with the fan units 200, the present invention places one or more insulation surfaces 248 at least partially around each fan unit 200 without disrupting air flow. The insulation surfaces 248 may include one or more of the sides, top, bottom, front, or back. Exemplary types of insulation include, but are not limited to traditional insulation board (such as that made from inorganic glass fibers (fiberglass) alone or with a factory-applied foil-scrim-kraft (FSK) facing or a factory-applied all service jacket (ASJ)) or alternative insulation such as open cell foam such as that disclosed in U.S. Patent Application No.10/606,435, which is assigned to the assignee of the present invention, and which the disclosure of which is hereby incorporated by reference herein. Together, the insulation surfaces 248 on the fan unit chambers 244 tend to function as a coplanar silencer. Some of the benefits of using the coplanar silencer include (1) no added airway length for splitters, (2) no pressure drop, and/or (3) relatively low cost. The acoustic advantages of this and other embodiments make the present invention ideal for use in concert halls, lecture halls, performing arts centers, libraries, hospitals, and other applications that are acoustically sensitive.

Although FIG. 17 shows the discharge plenum 210 positioned within the fan unit chambers 244, alternative embodiments of fan unit chambers 244 could enclose the inlet plenum 212, or at least partially enclose both the inlet plenum 212 and the discharge plenum 210. Still other alternative embodiments of fan unit chambers 244 may have grid or wire surfaces (that increase the safety of the present invention) or be open (that would reduce costs).

FIG. 18 shows an array of dampeners 250 that may be positioned either in front of or behind the fan units 200 to at least partially prevent back drafts. In the shown exemplary embodiment, the dampeners 250 include a plurality of plates, each plate positioned on its own pivot. In the shown exemplary embodiment, the plurality of plates slightly overlap each other. The shown embodiment is constructed such that when air is flowing through the fan units 200, the plates are in the open position and when the air

stops, gravity pulls the plates into the closed position. Preferably, each of the dampeners 250 operates independently such that if some of the fan units 200 are ON and some of the fan units 200 are OFF, the dampeners 250 can open or close accordingly. Although shown as a simple mechanical embodiment, alternative embodiments could include structure that is controlled electronically and/or remotely from the dampeners 250.

It should be noted that FIG. 4 shows a 4x6 fan array fan section in the air-handling system having twenty-four fan units 200, FIG. 5 shows a 5x5 fan array fan section in the air-handling system having twenty-five fan units 200, FIG. 6 shows a 3x4 fan array fan section in the air-handling system having twelve fan units 200, FIG. 7 shows a 3x3 fan array fan section in the air-handling system having nine fan units 200, and FIG. 8 shows a 3x1 fan array fan section in the air-handling system having three fan units 200. It should be noted that the array may be of any size or dimension of more than two fan units 200. It should be noted that although the fan units 200 may be arranged in a single plane (as shown in FIG. 3), an alternative array configuration could contain a plurality of fan units 200 that are arranged in a staggered configuration (as shown in FIG. 15) in multiple planes. It should be noted that cooling coils (not shown) could be added to the system either upstream or downstream of the fan units 200. It should be noted that, although shown upstream from the fan units 200, the filter bank 122, 222 could be downstream.

It should be noted that an alternative embodiment would use a horizontally arranged fan array. In other words, the embodiments shown in FIGS. 3-15 could be used horizontally or vertically or in any direction perpendicular to the direction of air flow. For example, if a vertical portion of air duct is functioning as the air-handling compartment 202, the fan array may be arranged horizontally. This embodiment would be particularly practical in an air handling compartment for a return air shaft.

It should be noted that the fan section 214 may be any portion of the airway path 220 in which the fan units 200 are positioned. For example, the fan units 200 may be situated in the discharge plenum 210 (as shown), the inlet plenum 212, or partially within the inlet plenum 212 and partially within the discharge plenum 210. It

should also be noted that the air-handling compartment 202 may be a section of air duct.

The terms and expressions that have been employed in the foregoing specification are used as terms of description and not of limitation, and are not intended to exclude equivalents of the features shown and described or portions of them. The scope of the invention is defined and limited only by the claims that follow.

WHAT IS CLAIMED IS:

1. A fan array fan section in an air-handling system comprising:
(a) at least three fan units;
(b) said at least three fan units arranged in a fan array;
(c) an air-handling compartment within which said fan array of fan units is positioned; and
(d) an array controller for controlling said at least three fan units to run at substantially peak efficiency.

2. The fan array fan section in an air-handling system of claim 1, wherein said at least three fan units are plenum fans.

3. The fan array fan section in an air-handling system of claim 1, wherein said air-handling compartment has an airway path, said airway path being less than 72 inches.

4. The fan array fan section in an air-handling system of claim 1, wherein said at least three fan units are a plurality of fan units arranged in a fan array configuration selected from the group consisting of:
(a) a true array configuration;
(b) a spaced pattern array configuration;
(c) a checker board array configuration;
(d) rows slightly offset array configuration;
(e) columns slightly offset array configuration; and
(f) a staggered array configuration.

5. The fan array fan section in an air-handling system of claim 1, wherein said at least three fan units are plenum fans include at least two vertically arranged fan units.

6. The fan array fan section in an air-handling system of claim 1, wherein each of said at least three fan units is positioned within a fan unit chamber.

7. The fan array fan section in an air-handling system of claim 1, wherein each of said at least three fan units is suspended within a fan unit chamber such that there is an air relief passage therebelow.

8. The fan array fan section in an air-handling system of claim 1, wherein each of said at least three fan units is positioned within a fan unit chamber having at least one insulation surface.

9. The fan array fan section in an air-handling system of claim 1, wherein each of said at least three fan units are mounted in a grid system.

10. The fan array fan section in an air-handling system of claim 1, wherein each of said at least three fan units has a fan wheel diameter, wherein spacing between said at least three fan units is less than 60% of said fan wheel diameter.

11. A fan array fan section in an air-handling system comprising:

(a) an air-handling compartment;

(b) a plurality of fan units;

(c) said plurality of fan units arranged in a fan array;

(d) said fan array having at least one fan unit arranged vertically on at least one other fan unit.

(e) said fan array positioned within said air-handling compartment.

12. The fan array fan section in an air-handling system of claim 11 further comprising an array controller programmed to operate said plurality of fan units at peak efficiency.

13. The fan array fan section in an air-handling system of claim 11, wherein said plurality of fan units are plenum fans.

14. The fan array fan section in an air-handling system of claim 11, wherein said air-handling compartment has an airway path, said airway path being less than 72 inches.

15. The fan array fan section in an air-handling system of claim 11, wherein said plurality of fan units are arranged in a fan array configuration selected from the group consisting of:

(a) a true array configuration;
(b) a spaced pattern array configuration;
(c) a checker board array configuration;
(d) rows slightly offset array configuration;
(e) columns slightly offset array configuration; and
(f) a staggered array configuration.

16. The fan array fan section in an air-handling system of claim 11, wherein each of said plurality of fan units is positioned within a fan unit chamber.

17. The fan array fan section in an air-handling system of claim 11, wherein each of said plurality of fan units is suspended within a fan unit chamber such that there is an air relief passage therebelow.

18. The fan array fan section in an air-handling system of claim 11, wherein each of said plurality of fan units is positioned within a fan unit chamber having at least one insulation surface.

19. The fan array fan section in an air-handling system of claim 11, wherein each of said plurality of fan units is mounted in a grid system.

20. The fan array fan section in an air-handling system of claim 11, wherein each of said plurality of fan units has a fan wheel diameter, wherein spacing between said plurality of fan units is less than 60% of said fan wheel diameter.

PTO/SB/01A (08-03)
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☒ The attached application, or

☐ Application No. _____, filed on _____,

☐ as amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Lawrence G. Hopkins

Signature: _____ Citizen of: U.S.

Inventor two: _____

Signature: _____ Citizen of: _____

Inventor three: _____

Signature: _____ Citizen of: _____

Inventor four: _____

Signature: _____ Citizen of: _____

☐ Additional inventors or a legal representative are being named on _____ additional form(s) attached hereto.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Hunt:FanArr1

PTO/SB/81 (09-03)
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POWER OF ATTORNEY and CORRESPONDENCE ADDRESS INDICATION FORM

Application Number	
Filing Date	March 22, 2004
First Named Inventor	Hopkins
Title	FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS
Art Unit	
Examiner Name	
Attorney Docket Number	HuntFanArr1

I hereby appoint:

[X] Practitioners associated with the Customer Number: 26790

OR

[ ] Practitioner(s) named below:

Name	Registration Number

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

Please recognize or change the correspondence address for the above-identified application to:

[X] The address associated with the above-mentioned Customer Number:

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OR

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	Address				
	Address				
	City		State		Zip
	Country				
	Telephone		Fax		

I am the:

[X] Applicant/Inventor.

[ ] Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Name	Lawrence G. Hopkins		
Signature			
Date	03-22-2004	Telephone	(503) 740-7610

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[X] *Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.31 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Application Number	
Filing Date	March 22, 2004
First Named Inventor	Hopkins
Title	FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS
Art Unit	
Examiner Name	
Attorney Docket Number	HuntFanArr1

I hereby appoint:

[X] Practitioners associated with the Customer Number: 26790

OR

[ ] Practitioner(s) named below:

Name	Registration Number

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

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[ ] Firm or Individual Name			
Address			
Address			
City		State	Zip
Country			
Telephone		Fax	

I am the:

[ ] Applicant/inventor.

[X] Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Name	Michael Post, Vice President of HUNTAIR
Signature	3-22-04
Date	03-22-2004
Telephone	(603) 504-6533

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[X] *Total of 2 forms are submitted.

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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Hopkins

Application No./Patent No.: _____ Filed/Issue Date: March 22, 2004

Entitled: FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS

HUNTAIR INC., a corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. ☒ the assignee of the entire right, title, and interest; or

2. ☐ an assignee of less than the entire right, title and interest.
The extent (by percentage) of its ownership interest is _____ %
in the patent application/patent identified above by virtue of either:

A. [X] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as shown below:

1. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
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3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
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[ ] Additional documents in the chain of title are listed on a supplemental sheet.

[ ] Copies of assignments or other documents in the chain of title are attached.
[NOTE: A separate copy (*i.e.*, the original assignment document or a true copy of the original document) must be submitted to Assignment Division in accordance with 37 CFR Part 3, if the assignment is to be recorded in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

March 22, 2004
Date

(503) 810-2560
Telephone number

Karen Dana Oster
Typed or printed name

Signature

Patent Attorney 37,621
Title

Hunt:FanArr1

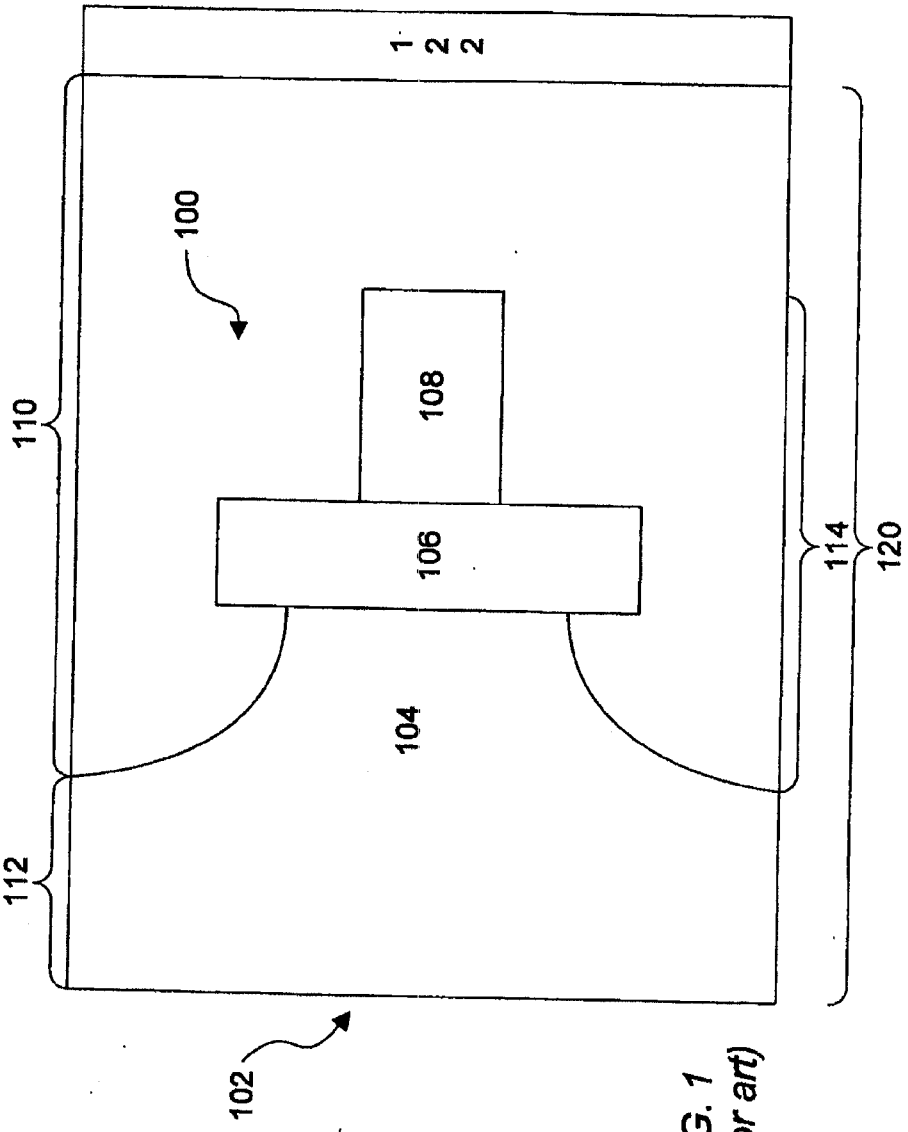

FIG. 1
(prior art)

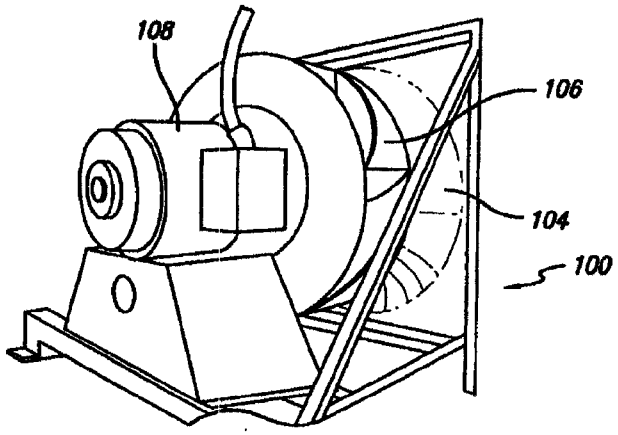

FIG. 2
(prior art)

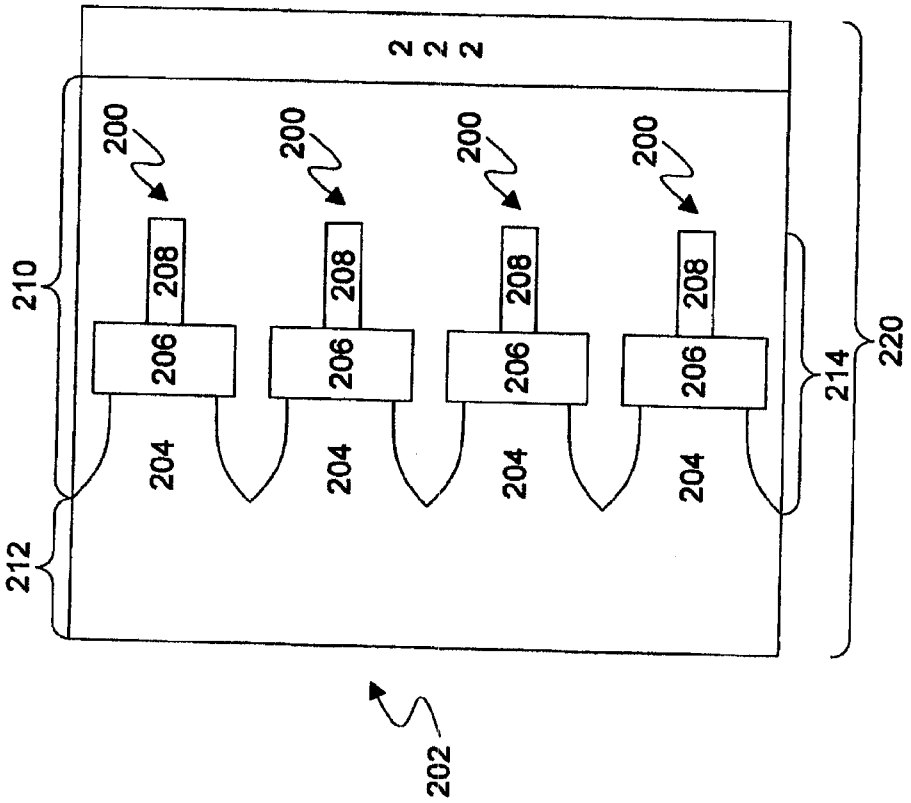
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FIG. 3

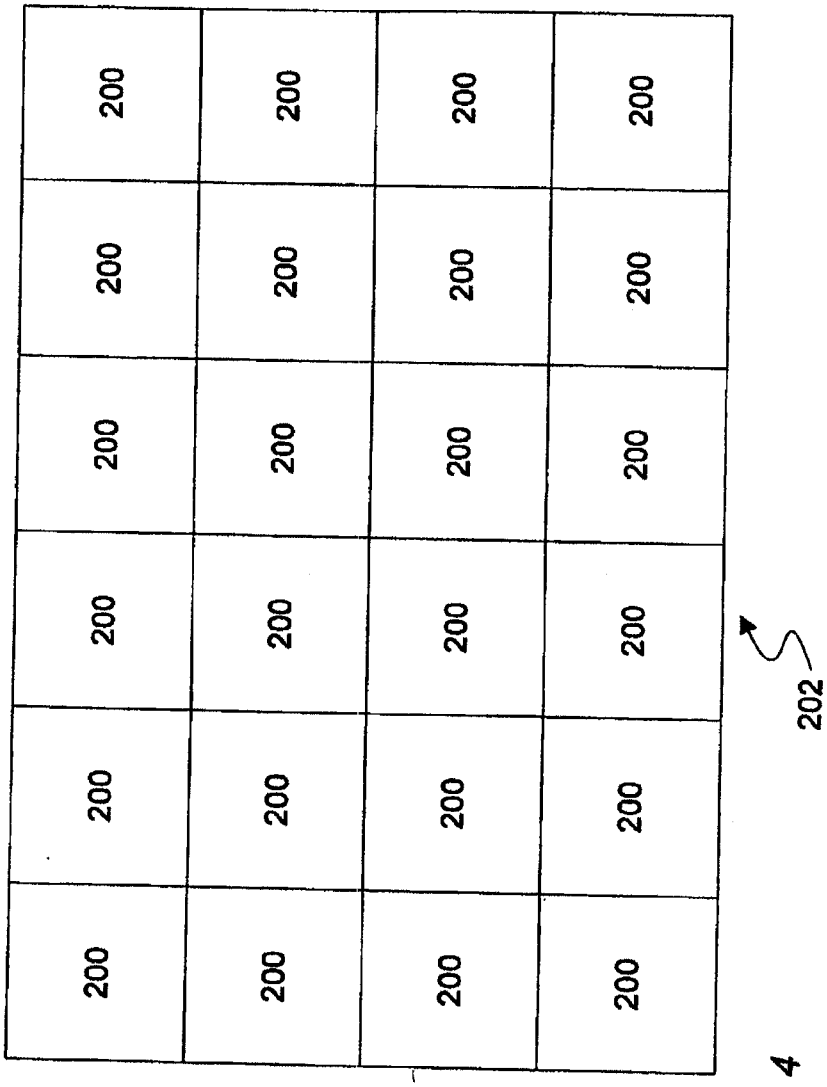

FIG. 4

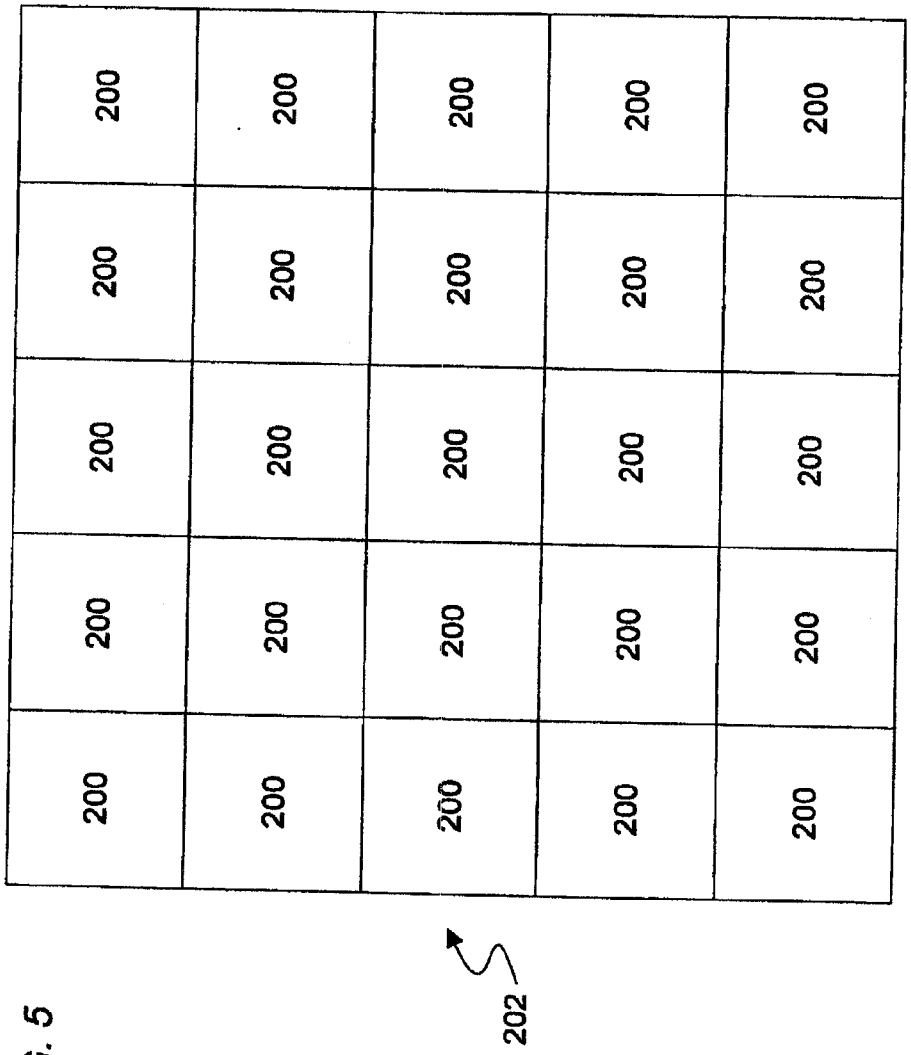
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FIG. 5

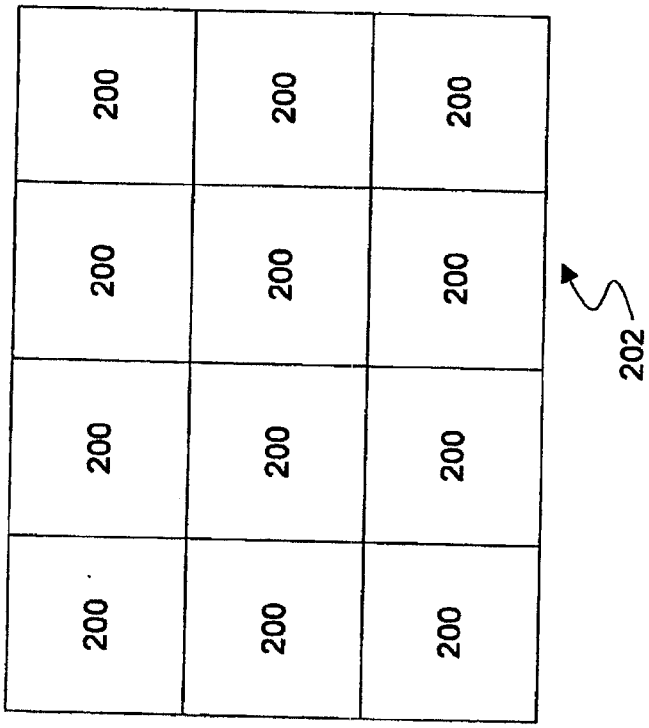

FIG. 6

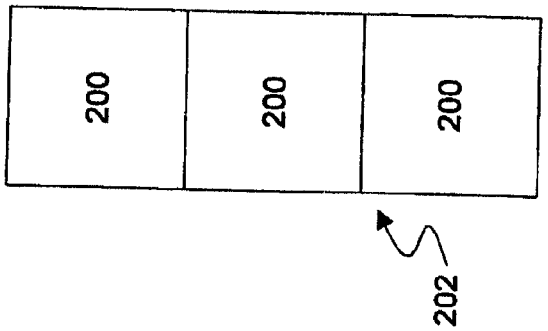

FIG. 8

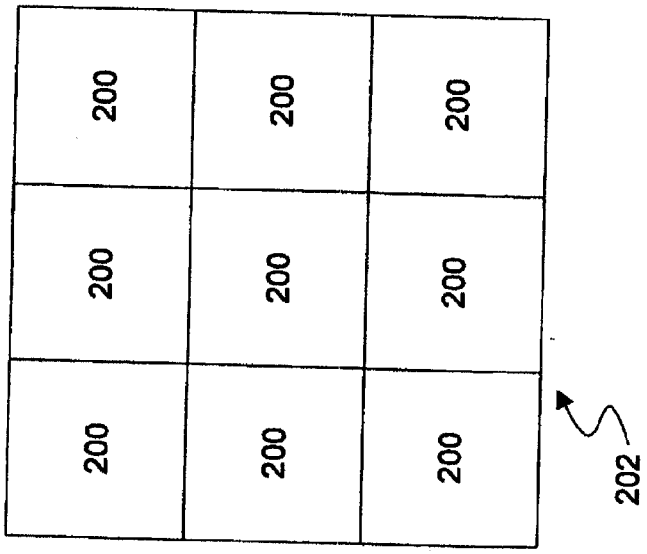

FIG. 7

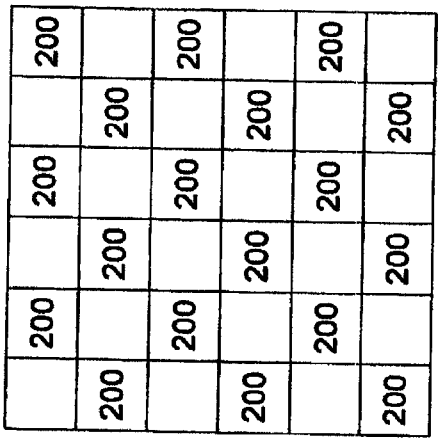

FIG. 10

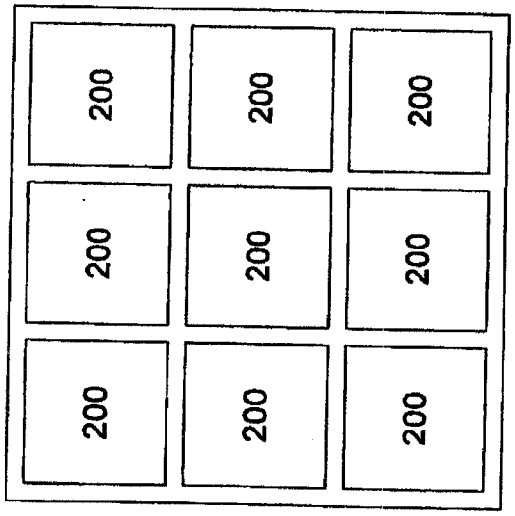

FIG. 9

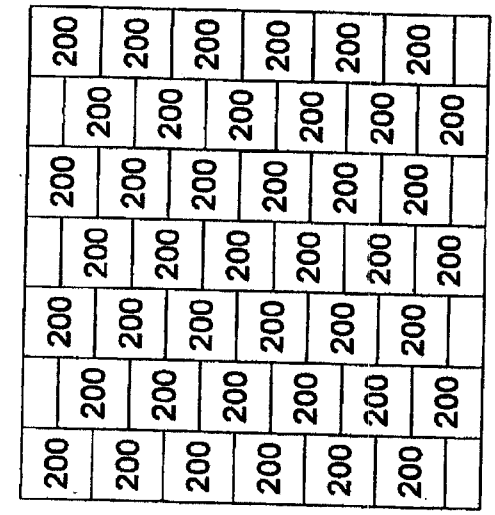

FIG. 12

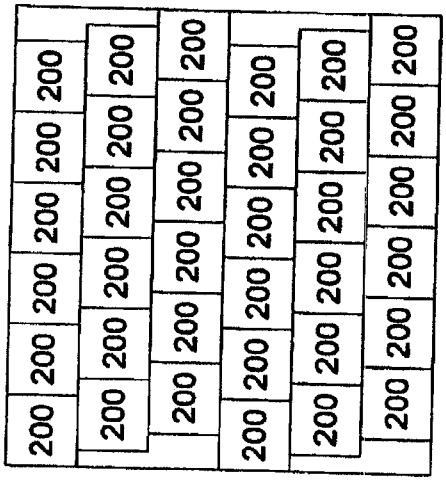

FIG. 11

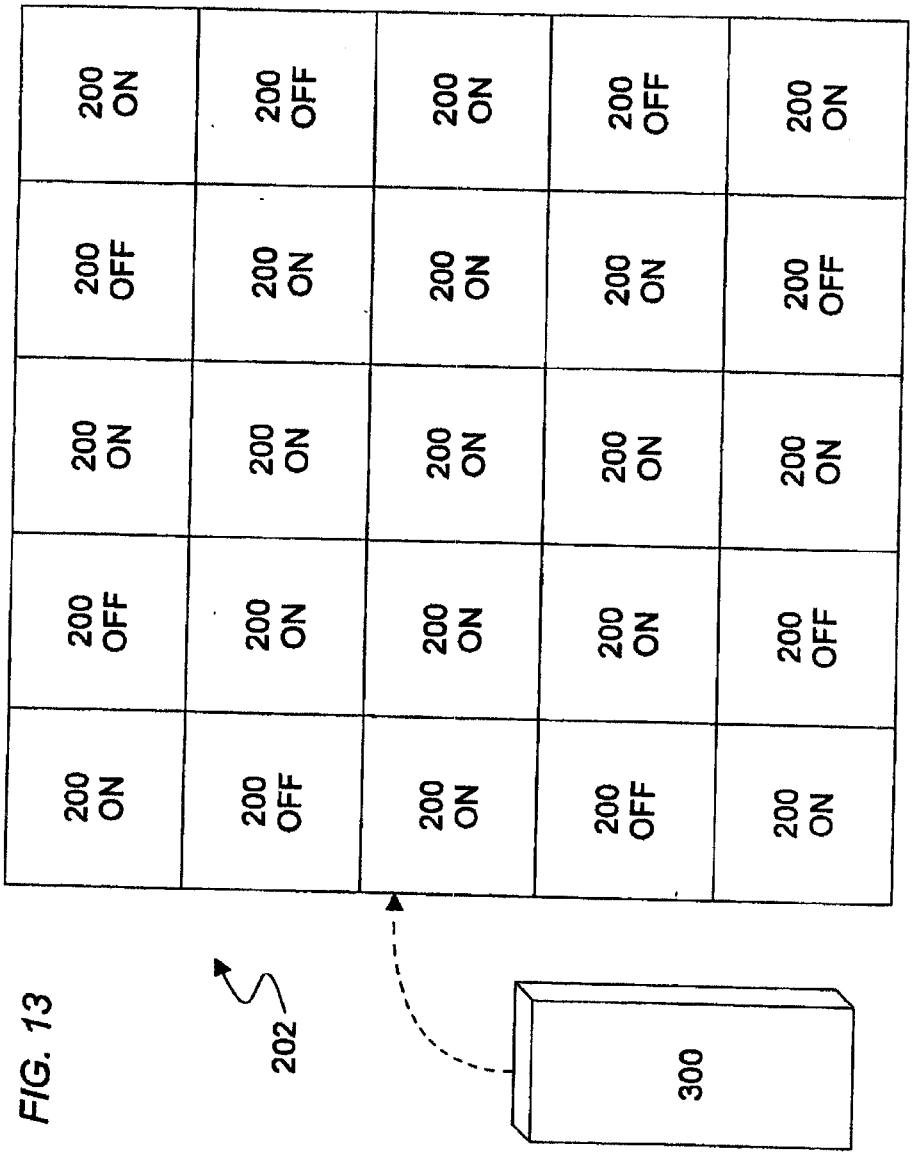
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FIG. 13

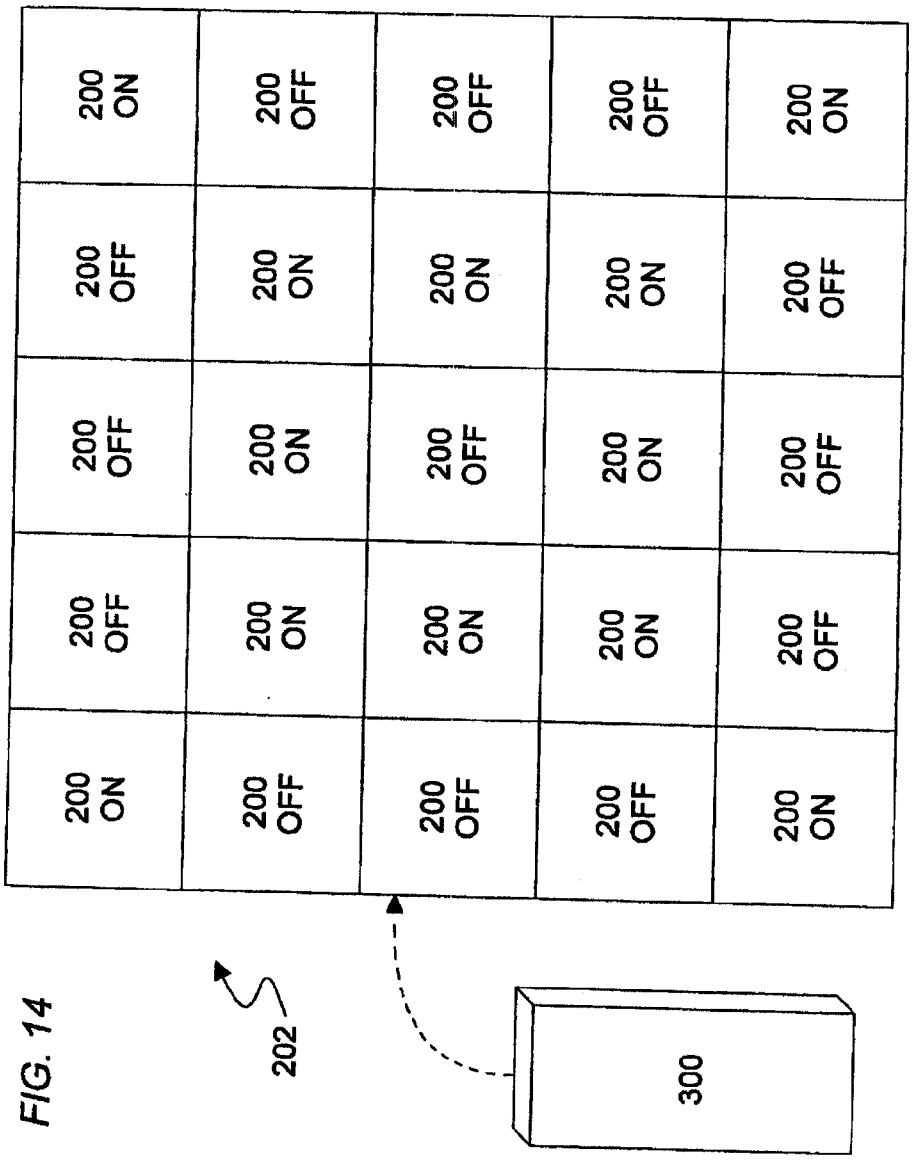
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FIG. 14

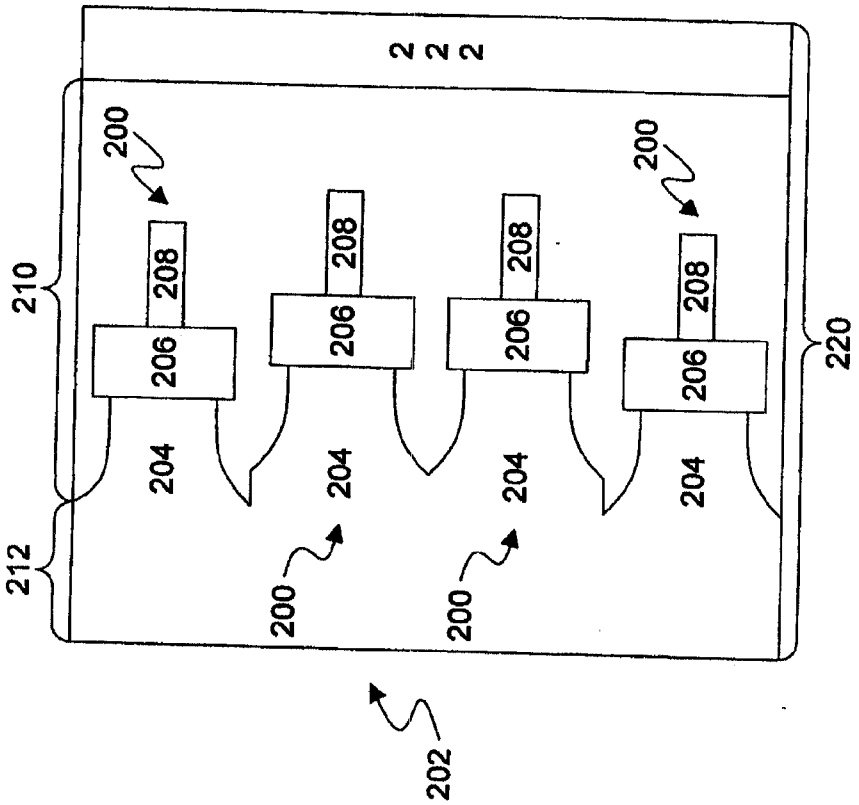

FIG. 15

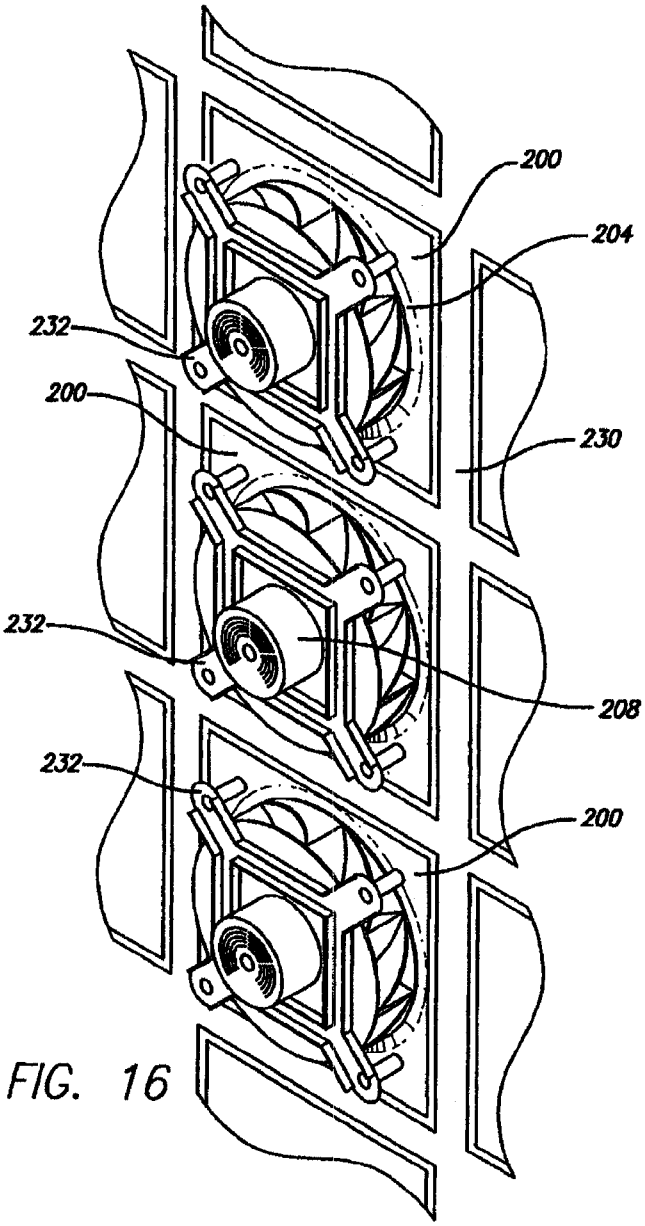

FIG. 16

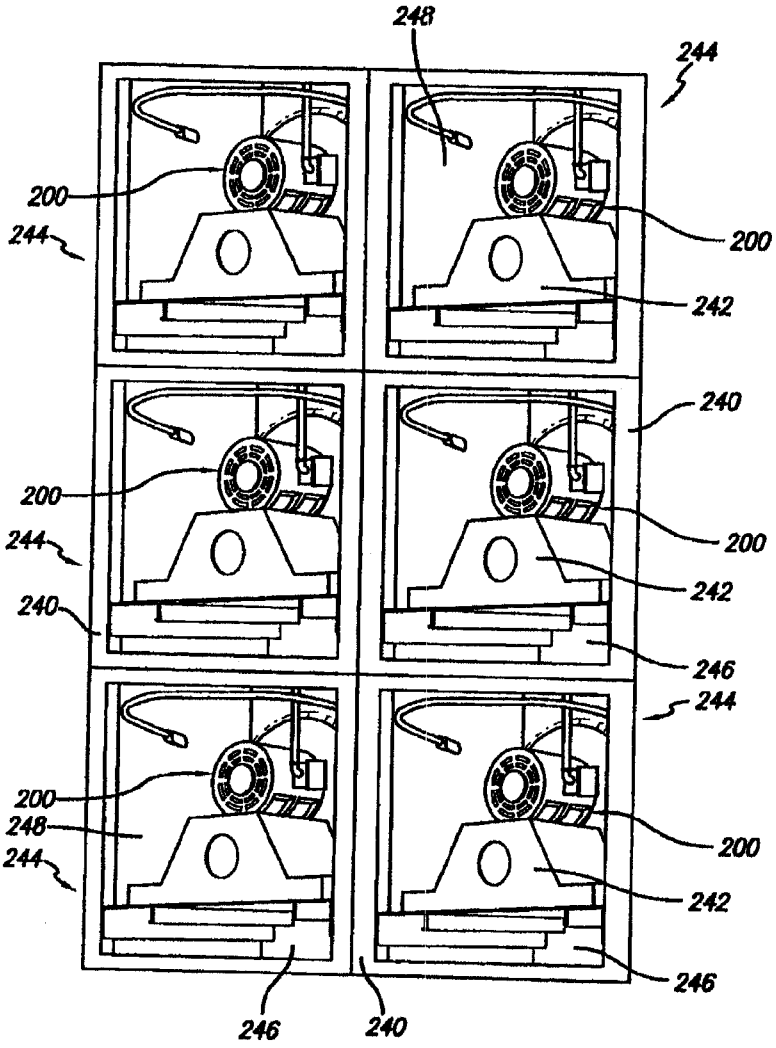
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FIG. 17

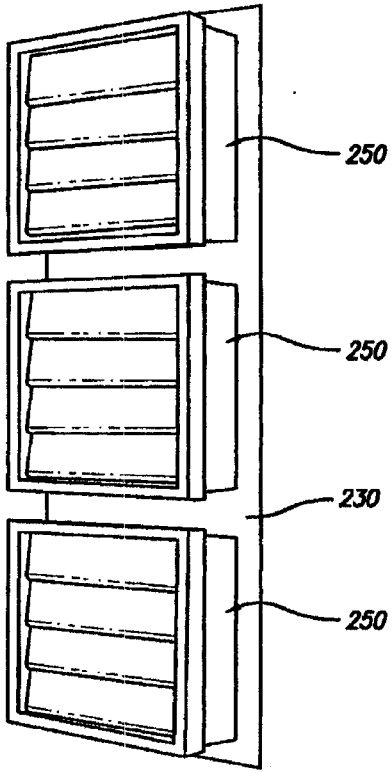

FIG. 18

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	
Filing Date	March 22, 2004
First Named Inventor	Hopkins
Art Unit	3745
Examiner Name	NINH NGUYEN
Attorney Docket Number	HunterAm1

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
NHN		US- 4767262	08-30-1988	Simon	
		US- 4133374	01-09-1979	York	
		US- 5632677	05-27-1997	Elkins	
		US- 6155335	12-05-2000	Acre et al.	
		US- 6386969 B1	05-14-2002	O'Brien	
		US- 6388880 B1	05-14-2002	El-Ghobashy et al.	
		US- 6407918 B1	06-18-2002	Edmunds et al.	
		US- 6414845 B2	07-02-2002	Bonet	
		US- 6427455 B1	08-06-2002	Furubayashi	
NHN		US- 6436130	08-20-2002	Phillips et al.	
		US-			
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		US-			

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T*

Examiner Signature	Mark H. Hopkins	Date Considered	09/10/04

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet 2 of 2

	Complete If Known
Application Number	10/806,775
Filing Date	03/22/2004
First Named Inventor	Lawrence G. Hopkins
Art Unit	3745
Examiner Name	Ninh H. Nguyen
Attorney Docket Number	HTR007-1P US (new)

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	5	AAON worksheet and drawing regarding Borders East Towers job for customer Borders Group, dated 02/26/2001 and 02/06/2001 (2 pages)	
	6	AAON order form, estimating worksheet, and facsimile transmission regarding The Commons job, dated 09/15/1998, 09/30/1998 and 06/30/1998 (3 pages)	
	7	AAON wiring diagram assignment and verification regarding Farm Show Arena job, 04/01/2002 (1 page)	
	8	AAON worksheet and drawing regarding Harrison Hills job, both dated 02/26/2002 (2 pages)	
	9	AAON RL Feature Master Number sheet, dated 10/17/2001 (1 page)	
	10	Mammouth Selection Guide for Custom Penthouse (200-410 Tons Cooling-only VAV configurations, 1992 (14 pages)	

Examiner Signature		Date Considered	01/23/06

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
1 Applicant's unique citation designation number (optional). 2 Applicant is to place a check mark here if English language Translation is attached.
This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Petition dated March 22, 2004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT APPLICATION EXAMINING OPERATIONS

Applicant:	Lawrence G. Hopkins	Group Art Unit:	
Serial No.:		Examiner:	
Filed:	March 22, 2004	Docket No:	Hunt:FanArr1

Title: FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS

PETITION TO MAKE SPECIAL BECAUSE OF ACTUAL INFRINGEMENT
(37 C.F.R. § 1.102 AND M.P.E.P. § 708.02)

Law Office of Karen Dana Oster, LLC
PMB 1020
15450 SW Boones Ferry Rd. #9
Lake Oswego, OR 97035
March 22, 2004

Mail Stop Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicant hereby petitions to make this application special because of actual infringement.

Accompanying this petition is a Statement of Facts in Support of Petition to Make Special Because of Actual Infringement and a Statement by Attorney in Support of Petition to make Special Because of Actual Infringement.

The fee required is to be paid by the attached check for $130.00. The Commissioner is hereby authorized to charge any additional fee, or credit any overpayment, to Deposit Account No. 50-2115. A duplicate copy of this sheet is enclosed.

The person making this statement is the attorney who signs below on the basis of the information supplied by the inventor and the information in the file.

Respectfully submitted,

03/25/2004 MBELETE1 00000004 10806775
02 FC:1460 130.00 OP

Karen Dana Oster
Reg. No. 37,621
Of Attorneys of Record
Tel: (503) 810-2560

Petition dated March 19, 2004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT APPLICATION EXAMINING OPERATIONS

Applicant:	Lawrence G. Hopkins	Group Art Unit:	
Serial No.:		Examiner:	
Filed:	March 22, 2004	Docket No:	Hunt:FanArr1

Title: FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS

STATEMENT OF FACTS IN SUPPORT OF PETITION TO MAKE SPECIAL
BECAUSE OF ACTUAL INFRINGEMENT (M.P.E.P. § 708.02)

Law Office of Karen Dana Oster, LLC
PMB 1020
15450 SW Boones Ferry Rd. #9
Lake Oswego, OR 97035
March 22, 2004

Mail Stop Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Lawrence G. Hopkins, whose address is 10781 SE Idleman Rd., Portalnd, OR 97266, am the inventor for the above-referenced patent application, and I hereby state the following:

1. I have been working in the air handling industry for 19 years. I received a Bachelor of Science degree in Mechanical Engineering from the University of Portland, in 1975 and obtained a Professional Engineering license in Oregon in 1982. I have authored numerous papers on fan and air handler design and presented papers at industry technical meetings such as the American Society for Heating, Refrigeration and Air conditioning Engineers, Cleanrooms and the Air Movement and Control Association. Currently, I am the Engineering Manager at HUNTAIR INC., the assignee of the present application. HUNTAIR INC. is a leader in airflow management for semiconductor manufacturing and the commercial/industrial air handling markets.

2. I invented the present invention. The invention goes against conventional wisdom pertaining to the use of multiple fans and spacing of multiple fans in air handling systems.

3. On March 20, 2003, United States Provisional Application 60/456,413 was filed in the Patent and Trademark Office. The present application claims priority from this provisional application.

4. After March 20, 2003, HUNTAIR INC. began marketing the invention described in the provisional application.

5. On or about October 12th, 2003, I became aware that Cleanpak International was bidding on projects based on the specifications of our inventions. This was my first indication of the existence of the product that I allege infringes at least one claim of the present application. I became aware of this after making a joint presentation with Richard Spradling of HUNTAIR INC., to Argonne Labs in Chicago. Upon learning of our invention, It is my understanding representatives from Cleanpak International offered to build a Fan Wall Array and presented this capability to the project designers at the Architect Engineering firm of Grumman-Butkus.

6. There is an actual infringement of this invention. Cleanpak International is currently offering the claimed invention for sale on their web site (www.cleanpak.com a copy of which is attached as Appendix A). Specifically, on the web site they have a Technical Bulletin in which they offer the CLEANPAK M/R/PF Multi/Redundant/Plenum Fan (attached as Appendix B). As an example of an infringing product, one of the products is described in the Technical Bulletin as an Xn+1 in which the "number of fans can be as high as 12-18, although it is not limited." The Technical Bulletin also specifies that "the Xn+1 can reduced the airway length." In the Vibration Isolation section of the Technical Bulletin, it is specified that Xn+1 systems may include stacked fans. Other descriptions of the Xn+1, how it works, and its advantages are also described in the Technical Bulletin.

7. A review of the Cleanpak International web site on March 27, 2003 (attached as Appendix C), April 7, 2003 (attached as Appendix D), and June 17, 2003 (attached as Appendix E) using the Wayback Machine at http://web.archive.org shows that Cleanpak International's Technical Bulletin was not on Cleanpak International's

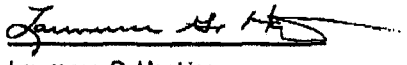
web site before June 17, 2003 (the most recent date available on the Wayback Machine.

8. It is my belief that Cleanpak International became aware of HUNTAIR INC.'s product and began offering its Xn+1 product in response thereto.

9. I declare that all statements made herein are of my own knowledge, are true, and that all statements made on information and belief are believed to the true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

The person making this statement is the inventor of the present invention.

Respectfully submitted,



Lawrence G. Hopkins
Inventor
Tel: (503) 403-4429

Petition dated March 22, 2004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT APPLICATION EXAMINING OPERATIONS

Applicant:	Lawrence G. Hopkins	Group Art Unit:
Serial No.:		Examiner:
Filed:	March 22, 2004	Docket No: Hunt:FanArr1
Title:	FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS	

STATEMENT IN SUPPORT OF PETITION TO MAKE SPECIAL
BECAUSE OF ACTUAL INFRINGEMENT (M.P.E.P. § 708.02)

Law Office of Karen Dana Oster, LLC
PMB 1020
15450 SW Boones Ferry Rd. #9
Lake Oswego, OR 97035
March 22, 2004

Mail Stop Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Karen Dana Oster, whose address is Law Office of Karen Dana Oster, LLC, PMB 1020, 15450 SW Boones Ferry Rd. #9, Lake Oswego, OR 97035, am the attorney of record for the above-referenced applicant, and make the following statements:

1. Applicant has 20 claims pending in the patent application submitted concurrently herewith. The claims are directed to a fan array fan section in an air-handling system.

2. Applicant has become aware that Cleanpak International is offering a Xn+1 product which is described Technical Bulletin in which they offer the CLEANPAK M/R/PF Multi/Redundant/Plenum Fan (attached as Appendix B) which is currently available at Cleanpak International's web site (www.cleanpak.com a copy of which is attached as Appendix A).

3. I have made a rigid comparison of the alleged infringing Xn+1 product (based on the Technical Bulletin as well as information provided by Lawrence G. Hopkins, the inventor for the above-referenced patent application) with the claims of

this application. All of the claimed elements of at least one of the claims are present in the Xn+1 product. Accordingly, in my opinion I believe that at least one of the claims on file in this application is unquestionably infringed.

4. In my opinion, and for exemplary purposes only, claim 1 on file in this application is unquestionably infringed. Claim 1 is currently pending as follows:

A fan array fan section in an air-handling system comprising:

(a) at least three fan units;

(b) said at least three fan units arranged in a fan array;

(c) an air-handling compartment within which said fan array of fan units is positioned; and

(d) an array controller for controlling said at least three fan units to run at peak efficiency.

According to the Technical Bulletin, Cleanpak International's Xn+1 product may include 12-18 fans (although the number is not limited), which clearly satisfies the element of "at least three fans." According to the Technical Bulletin, the fans may be stacked, which would correspond to the element of the "fan units arranged in a fan array." Cleanpak International's Xn+1 product would be implemented within an air-handling compartment. Cleanpak International's VFD which is used to run multiple motors would satisfy the element of the array controller.

5. In my opinion, and for exemplary purposes only, claim 10 on file in this application is unquestionably infringed. Claim 10 is currently pending as follows:

A fan array fan section in an air-handling system comprising:

(a) an air-handling compartment;

(b) a plurality of fan units;

(c) said plurality of fan units arranged in a fan array;

(d) said fan array having at least one fan unit stacked vertically on at least one other fan unit.

(e) said fan array positioned within said air-handling compartment.

Cleanpak International's Xn+1 product would be implemented within an air-handling compartment (elements (a) and (e)). According to the Technical Bulletin, Cleanpak International's Xn+1 product may include 12-18 fans (although the number is

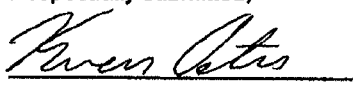
not limited), which clearly satisfies the element of "a plurality of fan units." According to the Technical Bulletin, the fans may be stacked, which would correspond to the element of the "fan units arranged in a fan array." In the Vibration Isolation section of the Technical Bulletin, it is specified that Xn+1 systems may include stacked fans, which wold satisfy the element of the "fan array having at least one fan unit stacked vertically on at least one other fan unit."

6. Applicant caused to be made a careful and thorough search of the prior art by a respected Washington search agent. I have reviewed the patents found in the formal search and believe that the claimed invention is patentable over the found references. All references found in the formal search are being provided to the Examiner along with a respective Information Disclosure Statement.

7. Further, Applicant has a good knowledge of the pertinent prior art. Specifically, Lawrence G. Hopkins has been working in the air handling industry for 19 years. Mr. Hopkins received a Bachelor of Science degree in Mechanical Engineering from the University of Portland, in 1975 and obtained a Professional Engineering license in Oregon in 1982. Mr. Hopkins has authored numerous papers on fan and air handler design and presented at industry technical meetings such as the American Society for Heating, Refrigeration and Air conditioning Engineers, Cleanrooms and the Air Movement and Control Association. During his experience, he has never see the claimed combination. Mr. Hopkins has provided me with several non-patent references that I have reviewed. I believe that the claimed invention is patentable over these non-patent references. All such non-patent references are being provided to the Examiner along with a respective Information Disclosure Statement.

8. I believe all the claims in this application as on file are allowable over the art of which I am aware.

Respectfully submitted,



Karen Dana Oster
Reg. No. 37,621
Of Attorneys of Record
Tel: (503) 810-2560

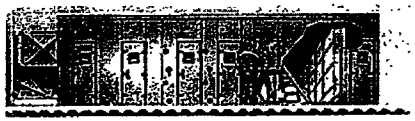
Appendix A

CLEANPAK International

Home
Recirculation Air Handler
Air Handling Unit
Air Movement Features
Fan Filter Units
Small Cabinet Fans
Ceiling Systems
- Clean-Trak
- SealTrak
- T-Trak
- SlimTrak
- Plenums
Ceiling System Features
- Lighting Calculations
- Fire Protection
Advantage Wall System
Access Floors
Parts Catalog
Search

info@cleanpak.com
503 557 4500

Air Movement Products
CLEANPAK offers a range of custom air handling products from fan filter units and recirculation air handlers to true no-through-metal thermal break air handling units and makeup air handling units for the cleanroom industry with semiconductor specific and life science specific products.



Ceiling Systems Products
CLEANPAK offers an array of modular and stick-built ceiling systems and plenums in patented flush and T-grid style, patented Bottom-Load Flush grid system, and a wealth of ceiling accessories and options such as our patented Clean-Screens®, Equalizers®, DualSeal Ports™, T5 lighting, and patented GelLink™, powder coated and stainless steel grid, and fiber optic grid lighting for hazardous areas.

Modular Cleanrooms
CLEANPAK offers the Servicor CPI line of modular cleanrooms.

Cleanroom Wall Systems
CLEANPAK offers the Advantage Cleanroom Wall System™ for maximum utility and flexibility.

tubes to technical bulletin

CLEANPAK is focused on designing and supplying clean room products and equipment. We target the semiconductor, pharmaceutical, aerospace, biotechnology, and nano-technology industries, as well as research laboratories and universities.

CLEANPAK ushered in a new era in cleanroom design with the use of direct drive plenum fans, now the standard for distributed recirculation air handler systems. We pioneered the use of the flush grid known as Clean-Trak®, which provides unparalleled flexibility and performance. We developed the first flexible sprinkler system, the first welded grid module, the first no fastener air handler cabinet, the Econo-Disk® for

current cache site

NEWS

CLEANPAK Inter
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The addition of
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FEATURED

Technical bullet
multi/redundant
applications.

CLEANPAK Inter
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guidelines of th
pharmaceutical
biotechnology i

volume control, the P-Cone® for airflow monitoring, low outgassing urethane gel, high-efficiency fan filter units with smart communications, high efficiency vane-axial fan units, Room-side Straight Load grid system, GelLink seal, DualSeal Ports--all CLEANPAK inventions that improve the way facilities operate. CLEANPAK has never stopped building on this strong foundation. The overall strengths we bring to the marketplace-innovation, high technology, breadth of product offerings, employee training and loyalty to customers-are evidenced by our history and are unsurpassed by any other supplier.

A number of pages contain documents that must be viewed with Acrobat reader, which you can download by clicking the "Get Acrobat Reader" image.

11241 SE Hwy 212 Clackamas, OR 97015 USA Tel:503.557.4500 Fax:503.557.4501
Sales: info@cleanpak.com Last modified: April 14, 2003

Appendix B

Technical Bulletin CLEANPAK M/R/PF Multi/Redundant/Plenum Fan

The application of multiple fans in a common system, in part, provided the impetus of the design of the "plug" fan years ago. CLEANPAK International has incorporated multiple fans in common cabinets for several years to provide systems that require redundancy, to meet architectural profile requirements, and for space savings. The arrangements may be vertical up or down flow or horizontal. The notes below apply generally, but often relate to redundancy issues, which is a benefit of multiple fan operation whether a design requirement or not.

General

There are three general arrangements for multiple plenum fan configurations as noted below. Each arrangement has its benefits.

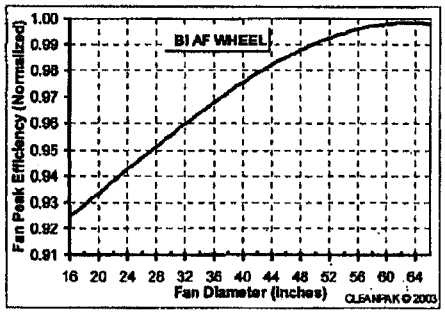
1+1: 2 fans can be provided in a cabinet with either fan capable of supplying 100% of the design flow requirement. This would provide 100% redundancy. Normal operation can be simultaneous or independent.

Twin: 2 fans can be provided in a cabinet with both fans required for the design flow. This arrangement provides capacity in excess of 50% if a single fan fails, since the system pressure drop falls by the square root of the volume decrease. Additional capacity can be provided by ramping the VFD up to the limit of the motor full load amps. Normal operation is always simultaneous.

Xn+1: This system provides a measure of redundancy by providing a number of fans smaller than that required by the 1+1 arrangement. The failure of a single fan is accommodated by the initiation of an unused fan, or the ramp up of all remaining fans. The number of fans can be as high as 12-18, although it is not limited. Normal operation is always simultaneous.

Airflow Isolation

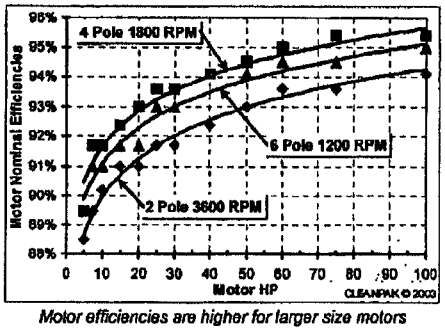
- Inlet or discharge isolation dampers with a solid dividing wall can be provided for fan service of an inoperative fan while operating at design flow for the 1+1 system. The damper pressure drop should be included in the calculation of the total static pressure (TSP).
- An Econo-Disk® may be provided for manual or automatic fan isolation for any of the applications, although as the fans become smaller (18" and under) performance penalties may result. Econo-Disk shutoff characteristics are excellent.
- Inlet isolation dampers can be provided and function similar to, but not as efficiently as, the Econo-Disk. Back draft dampers (heavy duty) can be used but may provide unstable operation at low flows. The damper pressure drop should be included in TSP calculations.
- If some sort of fan isolation is not provided, system performance will suffer a dramatic decrease with a fan failure, due to back flow through the failed fan.



Fan efficiencies are generally higher for larger size fans

Efficiency

- Larger diameter fans have significantly higher peak efficiencies than smaller diameter fans. Selecting fans at optimum efficiency for an operating point requires the ability to vary wheel width and operating speed.
- Larger motors are significantly more efficient than smaller motors.
- Motors operated at 75% full load are slightly more efficient than those that operate at 100% full load.



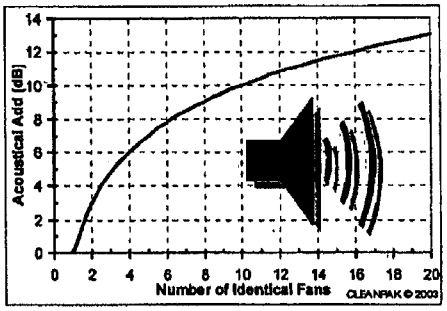
Motor efficiencies are higher for larger size motors

Technical Bulletin CLEANPAK M/R/PF Multi/Redundant/Plenum Fan

- System efficiency can be improved with internal and external pressure loss reductions such as low velocity coils and high capacity filters.

Dimensions
- For 1+1 systems, inlet and discharge plenum lengths may depend on the normal operating condition. Multiple fan configurations allow for more even velocity profiles for any given length than a single fan configuration.
- Larger fans take more airway length than smaller fans. Service access behind fans is similar for both large and small fans.
- Isolation dampers on the fan inlet increase the airway length.
- Isolation dampers on the fan outlet increase the airway length.
- Large numbers of fans operating as in Xn+1 can reduce the airway length compared to the 1+1 arrangement, particularly if the 1+1 design has an independent operating design rather than a simultaneous operating design.
- Unusual profiles may be accommodated with larger numbers of fans (Xn+1).

Pressure/Volume Control
- VFDs work well when the system follows the fan laws but do not work well if volume varies but the ESP is high and constant, or the fans operate with multiple volumes and constant pressure.
- The Econo-Disk can be used to provide volume control while maintaining design pressure with the simultaneous operation described in 1+1.
- Econo-Disks can be used for both volume and pressure control with manual, pneumatic, or electric actuation.
- Econo-Disks can be used with VFDs for increased flexibility and efficiency.
- Multiple fans such as Xn+1 can be staged and manipulated with VFDs and isolation dampers to offer constant pressure with variable volume.
- Multiple, simultaneous operating fans are generally operated at the same speed.
- Inlet isolation dampers can be used for volume control by "riding the curve" although this is not recommended since it is an inefficient method and may result in unstable operation.



Acoustical add for multiple sources

Sound
- Manufacturers' bare fan sound levels should be adjusted for multiple fan operation. Sound power levels are 11dB higher for 12 fans operating than for only one of the twelve.
- Smaller fans operate at higher speeds than larger fans for any given pressure. This shifts the primary tone of the fan (or blade passage frequency) to higher frequencies and may shift it to a higher octave band. Generally speaking this is advantageous in that higher frequencies are typically attenuated more easily.
- There is a potential for acoustical beats to arise with multiple fan systems.

Vibration Isolation
- 1+1 and twin fan operations are usually internally spring isolated.
- Xn+1 systems with stacked fans, racked, are usually provided without internal isolation, but can be internally spring isolated.

Service
- Smaller fans and motors are easier to physically manipulate than large fans and motors.

- System efficiency can be improved with internal and external pressure loss reductions such as low velocity coils and high capacity filters.

Dimensions
- For 1+1 systems, inlet and discharge plenum lengths may depend on the normal operating condition. Multiple fan configurations allow for more even velocity profiles for any given length than a single fan configuration.
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- VFDs work well when the system follows the fan laws but do not work well if volume varies but the ESP is high and constant, or the fans operate with multiple volumes and constant pressure.
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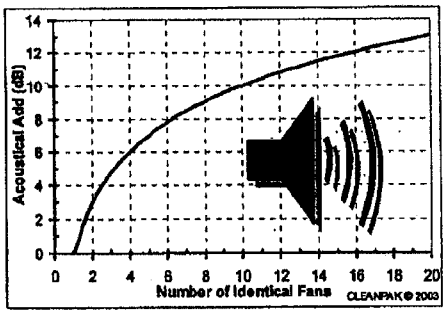

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Vibration Isolation
- 1+1 and twin fan operations are usually internally spring isolated.
- Xn+1 systems with stacked fans, racked, are usually provided without internal isolation, but can be internally spring isolated.

Service
- Smaller fans and motors are easier to physically manipulate than large fans and motors.

- Larger numbers of fans, motors, VFDs, dampers, and damper actuators increase service requirements and increase the potential points of failure.
- Generally a fan will be isolated until a system shutdown for major service, or if the fans are screened service is performed while one or more fans are operating.
- Service in an active air stream, without pressure and flow interference can be performed most easily with an airlock.
- Taperlock fan hubs offer quicker and simpler motor/fan wheel replacements than straight bore hubs.
- Bearing life is unaffected by the number of fans operating (1+1 or Xn+1), as the fewer fans use larger motors and bearings and operate at slower speeds.
- Aluminum wheels reduce the bearing load.
- Spare parts are less costly for small fans compared to larger fans.

Electrical

- 100% redundancy systems (1+1) require greater electrical service requirements than other systems but are as efficient or more efficient during operation.
- If single VFDs are used to run multiple motors, each motor requires separate overload protection. VFD to motor lead length is the sum of all the lead lengths fed by a single VFD.
- Multiple VFDs reduce the need for VFD bypass options.

Initial Cost

- $/CFM are lower for larger fans.
- $/HP are lower for larger motors and VFDs.
- Cabinet costs may be reduced with Xn+1 systems, due to the reduced cabinet length.

In the application of multiple smaller fans, one should consider several factors that affect initial cost, operating efficiency, redundancy, and reliability. The discussion above should help the designer evaluate the various options. Optimizing for single or multiple fan applications calls for flexibility from the air handling unit manufacturer. Please contact CLEANPAK's technical staff for further information and assistance with your application.

Appendix C

CLEANPAK INTERNATIONAL

- Home
- Recirculation Air Handler
- Air Handling Unit
- Air Movement Features
- Fan Filter Units
- Ceiling Systems
  Flush grid: Clean-Trak SealTrak
  T grid: T-Trak SlimTrak
  Plenums
- Ceiling System Features
  - Lighting Calculations
  - Fire Protection
- Access Floors
- Parts Catalog
- Quality Assurance
- Search

info@cleanpak.com
503 557 4500

CLEANPAK International

Air Movement Products
CLEANPAK offers a range of custom air handling products from fan filter units and recirculation air handlers to true no-through-metal thermal break air handling units and makeup air handling units for the cleanroom industry with semiconductor specific and life science specific products.

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CLEANPAK offers an array of modular and stick-built ceiling systems and plenums in patented flush and T-grid style, patented Bottom-Load Flush grid system, and a wealth of ceiling accessories and options such as our patented Clean-Screens®, Equalizers®, DualSeal Ports™, T5 lighting, and patented GelLink™, powder coated and stainless steel grid, and fiber optic grid lighting for hazardous areas.

Cleanpak is focused on designing and supplying cleanroom products. We target the semiconductor, pharmaceutical, aerospace, biotechnology, and nano-technology industries, as well as research laboratories and universities.

CLEANPAK ushered in a new era in cleanroom design with the use of direct drive plenum fans, now the standard for distributed recirculation air handler systems. We pioneered the use of the flush grid known as Clean-Trak®, which provides unparalleled flexibility and performance. We developed the first flexible sprinkler system, the first welded grid module, the first no fastener air handler cabinet, the Econo-Disk® for volume control, the P-Cone® for airflow monitoring, low outgassing urethane gel, high-efficiency fan filter units with smart communications, high efficiency vane-axial fan units, Room-side Straight Load grid system, GelLink seal, DualSeal Ports--all CLEANPAK inventions that improve the way facilities operate. CLEANPAK has never stopped building on this strong foundation. The overall strengths we bring to the marketplace–innovation, high technology, breadth of product offerings, employee training and loyalty to customers–are evidenced by our history and are unsurpassed by any other supplier.

3-27-2003

A number of pages contain documents that must be viewed with Acrobat reader, which you can download by clicking the "Get Acrobat Reader" image.

11241 SE Hwy 212 Clackamas, OR 97015 USA Tel:503.557.4500 Fax:503.557.4501
Sales: info@cleanpak.com Last modified: February 12, 2003

Appendix D

CLEANPAK™ INTERNATIONAL

info@cleanpak.com
503 557 4500

CLEANPAK International

Air Movement Products
CLEANPAK offers a range of custom air handling products from fan filter units and recirculation air handlers to true no-through-metal thermal break air handling units and makeup air handling units for the cleanroom industry with semiconductor specific and life science specific products.

Ceiling Systems Products
CLEANPAK offers an array of modular and stick-built ceiling systems and plenums in patented flush and T-grid style, patented Bottom-Load Flush grid system, and a wealth of ceiling accessories and options such as our patented Clean-Screens®, Equalizers®, DualSeal Ports™, T5 lighting, and patented GelLink™, powder coated and stainless steel grid, and fiber optic grid lighting for hazardous areas.

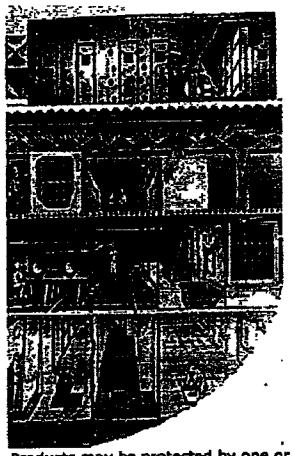
Modular Cleanrooms
CLEANPAK offers the Servicor CPI line of modular cleanrooms.

Cleanroom Wall Systems
CLEANPAK offers the Advantage Cleanroom Wall System™ for maximum utility and flexibility.

CLEANPAK is focused on designing and supplying clean room products and equipment. We target the semiconductor, pharmaceutical, aerospace, biotechnology, and nano-technology industries, as well as research laboratories and universities.

CLEANPAK ushered in a new era in cleanroom design with the use of direct drive plenum fans, now the standard for distributed recirculation air handler systems. We pioneered the use of the flush grid known as Clean-Trak®, which provides unparalleled flexibility and performance. We developed the first flexible sprinkler system, the first welded grid module, the first no fastener air handler cabinet, the Econo-Disk® for volume control, the P-Cone® for airflow monitoring, low outgassing urethane gel, high-efficiency fan filter units with smart communications, high efficiency vane-axial fan units, Room-side Straight Load grid system, GelLink seal, DualSeal Ports--all CLEANPAK inventions that improve the way facilities operate. CLEANPAK has never stopped building on this strong foundation. The overall strengths we

4-7-2003



bring to the marketplace–innovation, high technology, breadth of product offerings, employee training and loyalty to customers–are evidenced by our history and are unsurpassed by any other supplier.

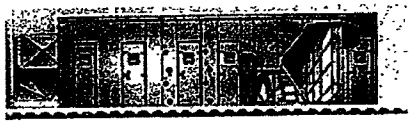
A number of pages contain documents that must be viewed with Acrobat reader, which you can download by clicking the "Get Acrobat Reader" image.

11241 SE Hwy 212 Clackamas, OR 97015 USA Tel:503.557.4500 Fax:503.557.4501
Sales: info@cleanpak.com Last modified: April 05, 2003

Appendix E

CLEANPAK International

Air Movement Products
CLEANPAK offers a range of custom air handling products from fan filter units and recirculation air handlers to true no-through-metal thermal break air handling units and makeup air handling units for the cleanroom industry with semiconductor specific and life science specific products.



Ceiling Systems Products
CLEANPAK offers an array of modular and stick-built ceiling systems and plenums in patented flush and T-grid style, patented Bottom-Load Flush grid system, and a wealth of ceiling accessories and options such as our patented Clean-Screens®, Equalizers®, DualSeal Ports™, T5 lighting, and patented GelLink™, powder coated and stainless steel grid, and fiber optic grid lighting for hazardous areas.

Modular Cleanrooms
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Cleanroom Wall Systems
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info@cleanpak.com
503 557 4500

CLEANPAK is focused on designing and supplying clean room products and equipment. We target the semiconductor, pharmaceutical, aerospace, biotechnology, and nano-technology industries, as well as research laboratories and universities.

CLEANPAK ushered in a new era in cleanroom design with the use of direct drive plenum fans, now the standard for distributed recirculation air handler systems. We pioneered the use of the flush grid known as Clean-Trak®, which provides unparalleled flexibility and performance. We developed the first flexible sprinkler system, the first welded grid module, the first no fastener air handler cabinet, the Econo-Disk® for volume control, the P-Cone® for airflow monitoring, low outgassing urethane gel, high-

NEWS

CLEANPAK Inter announces the i of the Advantag Cleanroom Wall from ASD. Deve input from both users and instal Advantage Clea System is desig provide maximu and flexibility.

The addition of Advantage Clea System continu International's c to provide innov products design the industry-spe requirements of customers.

FEATURED

CLEANPAK Inter offers a seamle steel bottom-loa system designe the most string guidelines of th pharmaceutical biotechnology i

6-17-2003

efficiency fan filter units with smart communications, high efficiency vane-axial fan units, Room-side Straight Load grid system, GelLink seal, DualSeal Ports--all CLEANPAK inventions that improve the way facilities operate. CLEANPAK has never stopped building on this strong foundation. The overall strengths we bring to the marketplace–innovation, high technology, breadth of product offerings, employee training and loyalty to customers–are evidenced by our history and are unsurpassed by any other supplier.

A number of pages contain documents that must be viewed with Acrobat reader, which you can download by clicking the "Get Acrobat Reader" image.

11241 SE Hwy 212 Clackamas, OR 97015 USA Tel:503.557.4500 Fax:503.557.4501
Sales: info@cleanpak.com Last modified: April 14, 2003

APPLICATION DATA SHEET

Application Information

Application Number::	Concurrently Herewith
Filing Date::	March 22, 2004
Application Type::	Regular
Subject Matter::	Utility
Title::	FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS
Attorney Docket Number::	Hunt:FanArr1
Request For Early Publication::	No
Request For Non-Publication::	No
Suggested Drawing Figure::	3
Total Drawing Sheets::	15
Small Entity::	Yes

Applicant Information

Applicant Authority Type::	Inventor
Primary Citizenship Country::	U.S.
Status::	Full Capacity
Given Name::	Lawrence
Middle Name::	G.
Family Name::	Hopkins
Name Suffix::	
City Of Residence::	Portland
State Or Province Of Residence::	Oregon
Country Of Residence::	U.S.
Street Of Mailing Address::	10781 SE Idleman Rd.
City Of Mailing Address::	Portland
State Or Province Of Mailing Address::	Oregon
Country Of Mailing Address::	U.S.
Postal Or Zip Code Of Mailing Address::	97266

Correspondence Information

Correspondence Customer Number::	26790
Phone Number::	(503) 810-2560
Fax Number::	(503) 638-0367
E-Mail Address::	Karen@kdopatent.com

Representative Information

Representative Customer Number::	26790

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
This Application	An application claiming the benefit under 35 USC 119(e)	60/456,413	03/20/03
This Application	A continuation in part		03/19/04
This Application	An application claiming the benefit under 35 USC 119(e)		03/20/04

Assignee Information

Assignee Name::	HUNTAIR INC.
Primary Citizenship Country::	Oregon
Street Of Mailing Address::	11555 SW Myslony Street
City Of Mailing Address::	Tualatin
State Or Province Of Mailing Address::	Oregon
Country Of Mailing Address::	USA
Postal Or Zip Code Of Mailing Address::	97062

CERTIFICATE UNDER 37 CFR 1.10
CERTIFICATE OF MAILING BY
"EXPRESS MAIL"

Express Mail No.: EU122438309US
Date of Deposit: March 22, 2004

I hereby certify that the following documents relating to a New U.S. Utility Patent Application entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS and invented by Hopkins are being deposited with the United States Postal Service, "Express Mail Post Office to Addressee" service under 37 CFR 1.10, on the date indicated above and is addressed to Mail Stop PATENT APPLICATION, Commissioner for Patents, P.O. Box 1450; Alexandria, VA 22313-1450.

- ☒ Utility Patent Application Transmittal Form (1 sheet(s))
- ☒ a return acknowledgement postcard
- ☒ Fee Transmittal Form (in duplicate) and check for $385 for filing fees
- ☒ Specification (25 pages)
- ☒ Drawings (FIGS. 1- 18)(15 sheets)
- ☒ Oath/Declaration(s)
- ☒ Patent Application Data Sheet
- ☒ Assignment Cover Sheet and Assignment(s) and check for $40 for assignment fee
- ☒ Power of Attorney(s)
- ☒ 373(b) form ~~(and attached copies of Assignment(s) and POA(s))~~
- ☒ Information Disclosure Statement and attached reference(s)
- ☒ Petition to Make Special & check for $130
- ☒ this Certificate of Mailing by Express Mail

Karen Dana Oster

PTO/SB/17 (10-03)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

FEE TRANSMITTAL for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 385

Complete if Known	
Application Number	
Filing Date	March 22, 2004
First Named Inventor	Hopkins
Examiner Name	
Art Unit	
Attorney Docket No.	Hunt:FanArm

METHOD OF PAYMENT *(check all that apply)*

☒ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number: 50-2115

Deposit Account Name:

The Director is authorized to: *(check all that apply)*

☒ Charge fee(s) indicated below ☒ Credit any overpayments

☒ Charge any additional fee(s) or any underpayment of fee(s)

☐ Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	770	2001	385	Utility filing fee	385
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	

SUBTOTAL (1) ($) 385

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

	Extra Claims		Fee from below	Fee Paid
Total Claims		-20** =	X	0
Independent Claims		-3** =	X	0
Multiple Dependent				

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for *ex parte* reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify)

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) ($) 0

SUBMITTED BY

(Complete *if applicable*)

Name (Print/Type)	Karen Dana Oster	Registration No. (Attorney/Agent)	37,621	Telephone	(503) 810-2560
Signature				Date	March 22, 2004

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

PTO/SB/05 (01-04)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office. U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	Hunt:FanArr1
First Inventor	Hopkins
Title	FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS
Express Mail Label No.	EU122438309US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Mail Stop Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria VA 22313-1450

1. [X] Fee Transmittal Form (e.g., PTO/SB/17) and check *(Submit an original and a duplicate for fee processing)*
2. [X] Applicant claims small entity status. See 37 CFR 1.27.
3. [X] Specification [*Total Pages* 25]
   (preferred arrangement set forth below)
   - Descriptive title of the invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. [X] Drawing(s) (*35 U.S.C. 113*) [*Total Sheets* 15]
5. Oath or Declaration [*Total Sheets* 1]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 18 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) name in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. [X] Application Data Sheet. See 37 CFR 1.76
7. [ ] CD-ROM or CD-R in duplicate, large table or Computer Program *(Appendix)*
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. [X] Assignment Papers (cover sheet, document(s), and check)
10. [X] 37 CFR 3.73(b) Statement [X] Power of Attorney *(when there is an assignee)*
11. [ ] English Translation Document *(if applicable)*
12. [X] Information Disclosure Statement (IDS)/PTO-1449 [X] Copies of IDS Citations (for non US patent references)
13. [ ] Preliminary Amendment
14. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35
17. [X] Other: Petition to Make Special & Attachments (including $130 check); and Certificate of Express Mail

The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number 60/456,413, filed March 20, 2003, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a continuation-in-part application of PCT Patent Application Serial Number _____, filed March 19, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number _____, filed March 20, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS.

19. CORRESPONDENCE ADDRESS

[X] Customer Number: 26790 *OR* [ ] Correspondence address below

Name					
Address					
City		*State*		*Zip Code*	
Country		*Telephone*		*Fax*	

Name (Print/Type)	Karen Dana Oster	*Registration No. (Attorney/Agent)*	37,621
Signature		*Date*	March 22, 2004

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPL NO.	FILING OR 371 (c) DATE	ART UNIT	FIL FEE REC'D	ATTY.DOCKET NO	DRAWINGS	TOT CLMS	IND CLMS
10/806,775	03/22/2004	3744	385	Hunt:FanArr1	15	20	2

CONFIRMATION NO. 2371

26790
LAW OFFICE OF KAREN DANA OSTER, LLC
PMB 1020
15450 SW BOONES FERRY ROAD #9
LAKE OSWEGO, OR 97035

FILING RECEIPT
OC000000012930983
OC000000012930983

Date Mailed: 06/14/2004

Receipt is acknowledged of this regular Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Filing Receipt Corrections, facsimile number 703-746-9195. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).**

Applicant(s)
Lawrence G. Hopkins, Portland, OR;

Assignment For Published Patent Application
HUNTAIR INC., Tualatin, OR;

Domestic Priority data as claimed by applicant
This appln claims benefit of 60/456,413 03/20/2003
This application claims benefit of 60/554,702 3/20/04

Foreign Applications
This application is a continuation-in-part application of PCT patent application PCT/US2004/008578 3/19/04

If Required, Foreign Filing License Granted: 06/08/2004

Docketed

Projected Publication Date: 09/23/2004

Non-Publication Request: No

Early Publication Request: No

Law Office of
Karen Dana Oster, LLC
Received
JUN 16 2004

**** SMALL ENTITY ****

Title
Fan array fan section in air-handling systems

Preliminary Class
454

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Office of Export Administration, Department of Commerce (15 CFR 370.10 (j)); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

Express Mail No. EU122438309US

FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS

The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number 60/456,413, filed March 20, 2003, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a continuation-in-part application of PCT Patent Application Serial Number _____, filed March 19, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number _____, filed March 20, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is based on and claims priority from these applications, the disclosures of which are hereby expressly incorporated herein by reference.

Application No. 10/806,775
Amendment dated August 2, 2004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT APPLICATION EXAMINING OPERATIONS

Applicant:	Hopkins	Group Art Unit:
Serial No.:	10/806,775	Examiner:
Filed:	March 22, 2004	Docket No: Hunt:FanArr1
Title:	Fan Array Fan Section in Air-Handling Systems	

PRELIMINARY AMENDMENT

Law Office of Karen Dana Oster, LLC
PMB 1020
15450 SW Boones Ferry Rd. #9
Lake Oswego, OR 97035
August 2, 2004

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Prior to examination, please amend the above-identified patent application as follows:

Amendments to the Specification begin on page 2 of this paper.

Remarks/Arguments begin on page 3 of this paper.

Application No. 10/806,775
Amendment dated August 2, 2004

Amendments to the Specification:

Please replace the paragraph beginning at page 1, line 3, with the following rewritten paragraph:

-- The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number 60/456,413, filed March 20, 2003, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a continuation-in-part application of PCT Patent Application Serial Number PCT/US2004/008578 [[_____]], filed March 19, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number 60/554,702 [[_____]], filed March 20, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is based on and claims priority from these applications, the disclosures of which are hereby expressly incorporated herein by reference. --

Application No. 10/806,775
Amendment dated August 2, 2004

REMARKS

Applicant is amending the specification of the present invention to specifically include the serial numbers of the applications from which this application claims priority. In the originally submitted application, the priority applications were identified with all the information in applicant's possession at the time of filing. Identifying information of the priority applications included the filing dates and titles.

Applicant respectfully submits that the specification be amended and that appropriate priority be given. Applicant respectfully requests that a corrected filing receipt be provided.

A copy of this Preliminary Amendment is being sent by facsimile directly to the Office of Initial Patent Examination's Filing Receipt Corrections.

Please charge Deposit Account No. 50-2115 for any additional fees which may be required.

Respectfully submitted,

Karen Dana Oster
Reg. No. 37,621
Of Attorneys of Record
Tel: (503) 810-2560

PTO/SB/17 (10-03)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

FEE TRANSMITTAL for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 0

Complete if Known	
Application Number	10/806,775
Filing Date	March 22, 2004
First Named Inventor	Hopkins
Examiner Name	
Art Unit	
Attorney Docket No.	HuntFanArm

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number: 50-2115

Deposit Account Name:

The Director is authorized to: (check all that apply)

☒ Charge fee(s) indicated below ☒ Credit any overpayments

☒ Charge any additional fee(s) or any underpayment of fee(s)

☐ Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	

SUBTOTAL (1) ($) 0

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

	Extra Claims		Fee from below	Fee Paid
Total Claims		-20** =	x	= 0
Independent Claims		-3** =	x	= 0
Multiple Dependent				

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for *ex parte* reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify)

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) ($) 0

SUBMITTED BY					(Complete if applicable)
Name (Print/Type)	Karen Dana Oster	Registration No. (Attorney/Agent)	37,621	Telephone	(503) 810-2560
Signature				Date	August 2, 2004

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JC

JCWSCS 02 AUG 2004

Aug 02 04 07:17a KAREN 503-638-0367 p.1

FILE COPY

PTO/SB/21 (04-04)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/806,775
Filing Date	March 22, 2004
First Named Inventor	Hopkins
Art Unit	
Examiner Name	
Total Number of Pages in This Submission: 9	Attorney Docket Number: Hunt:FanArr1

ENCLOSURES *(Check all that apply)*

- [X] Fee Transmittal Form in duplicate
- [ ] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
- [ ] After Allowance communication to Technology Center (TC)
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC (Appeal Notice, Brief, Reply Brief)
- [ ] Proprietary Information
- [ ] Status Letter
- [X] Other Enclosure(s) (please identify below):

Filing receipt with corrections indicated thereon; copy of Page 1 of original application; copy of Preliminary Amendment

Remarks

Please correct filing receipt to reflect that the present application is a continuation-in-part application of PCT Patent Application Serial Number PCT/US2004/008578, filed March 19, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS and is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number 60/554,702, filed March 20, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm or Individual name	Karen Dana Oster
Signature	Karen Oster
Date	August 2, 2004

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.

Typed or printed name	Karen Dana Oster		
Signature	Karen Oster	Date	August 2, 2004

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IFW

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT APPLICATION EXAMINING OPERATIONS

Applicant:	Hopkins	Group Art Unit:
Serial No.:	10/806,775	Examiner:
Filed:	March 22, 2004	Docket No: Hunt:FanArr1
Title:	Fan Array Fan Section in Air-Handling Systems	

PRELIMINARY AMENDMENT

Law Office of Karen Dana Oster, LLC
PMB 1020
15450 SW Boones Ferry Rd. #9
Lake Oswego, OR 97035
August 2, 2004

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Prior to examination, please amend the above-identified patent application as follows:

Amendments to the Specification begin on page 2 of this paper.

Remarks/Arguments begin on page 3 of this paper.

Amendments to the Specification:

Please replace the paragraph beginning at page 1, line 3, with the following rewritten paragraph:

-- The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number 60/456,413, filed March 20, 2003, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a continuation-in-part application of PCT Patent Application Serial Number PCT/US2004/008578 [[_____]], filed March 19, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is a nonprovisional application claiming the benefit under 35 USC Section 119(e) of U.S. Provisional Patent Application Serial Number 60/554,702 [[_____]], filed March 20, 2004, and entitled FAN ARRAY FAN SECTION IN AIR-HANDLING SYSTEMS. The present application is based on and claims priority from these applications, the disclosures of which are hereby expressly incorporated herein by reference. --

REMARKS

Applicant is amending the specification of the present invention to specifically include the serial numbers of the applications from which this application claims priority. In the originally submitted application, the priority applications were identified with all the information in applicant's possession at the time of filing. Identifying information of the priority applications included the filing dates and titles.

Applicant respectfully submits that the specification be amended and that appropriate priority be given. Applicant respectfully requests that a corrected filing receipt be provided.

A copy of this Preliminary Amendment is being sent by facsimile directly to the Office of Initial Patent Examination's Filing Receipt Corrections.

Please charge Deposit Account No. 50-2115 for any additional fees which may be required.

Respectfully submitted,

Karen Dana Oster
Reg. No. 37,621
Of Attorneys of Record
Tel: (503) 810-2560

PTO/SB/17 (10-03)
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Complete if Known	
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Filing Date	March 22, 2004
First Named Inventor	Hopkins
Examiner Name	
Art Unit	
Attorney Docket No.	Hunt:FanArr1

METHOD OF PAYMENT *(check all that apply)*

☐ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number: 50-2115

Deposit Account Name:

The Director is authorized to: *(check all that apply)*

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Multiple Dependent				=

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SUBTOTAL (2) ($) 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

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1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 0

SUBMITTED BY

(Complete *(if applicable)*)

Name (Print/Type)	Karen Dana Oster	Registration No. (Attorney/Agent)	37,621	Telephone	(503) 810-2560
Signature				Date	August 2, 2004

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

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PTO/SB/21 (04-04)
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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/806,775
Filing Date	March 22, 2004
First Named Inventor	Hopkins
Art Unit	
Examiner Name	
Attorney Docket Number	Hunt:FanArr1

Total Number of Pages in This Submission: 7

ENCLOSURES *(Check all that apply)*

- [X] Fee Transmittal Form in duplicate
- [ ] Fee Attached
- [X] Amendment/Reply
  - [X] Preliminary
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
- [ ] After Allowance communication to Technology Center (TC)
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC (Appeal Notice, Brief, Reply Brief)
- [ ] Proprietary Information
- [ ] Status Letter
- [X] Other Enclosure(s) (please identify below): see remarks

Remarks: return receipt postcard

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm or Individual name	Karen Dana Oster
Signature	Karen Oster
Date	August 2, 2004

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.

Typed or printed name	Karen Dana Oster		
Signature	Karen Oster	Date	August 2, 2004

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/806,775	03/22/2004	Lawrence G. Hopkins	Hunt:FanArr1	2371

26790 7590 09/15/2004

LAW OFFICE OF KAREN DANA OSTER, LLC
PMB 1020
15450 SW BOONES FERRY ROAD #9
LAKE OSWEGO, OR 97035

EXAMINER	
NGUYEN, NINH H	

ART UNIT	PAPER NUMBER
3745	

DATE MAILED: 09/15/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)	
	10/806,775	HOPKINS, LAWRENCE G.	
	Examiner	Art Unit	
	Ninh H. Nguyen	3745	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-20 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-20 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 22 March 2004 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 03/22/04.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

U.S. Patent and Trademark Office
PTOL-326 (Rev. 1-04) **Office Action Summary** Part of Paper No./Mail Date 09102004